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A CLINICAL LECTURE ON CANCER OF THE RECTUM

IN the war against cancer which is occupying so much attention at this time the battle cry is early treatment, which, of course, means early diagnosis. Cancer of the rectum forms no exception to this rule. With the present-day improved technic in the surgery of the rectum early operation should provide a somewhat brighter page in the dark history of cancer. Unfortunately, early diagnosis is hampered by the fact that, like cancer elsewhere in the body, the disease may develop and progress to a serious stage before it presents any urgent symptoms. While this circumstance represents one cause for the failure to seek advice early in the disease, a second, more controllable, and I may say, inexcusable cause, is failure to recognize the conditions that carry with them the possibility of cancer of the large bowel. That is to say, failure to make a rectal examination as a routine in cases of unusual constipation associated with rectal discomfort, a sense of incomplete evacuation, especially if the patient is past middle life.

Etiologically, cancer of the rectum shows the same preference as does malignancy in general for the later decades of life, between the fiftieth and sixtieth year, although it has been known to occur as early as the fourteenth year and as late as the eightieth or the ninetieth year. It shows no marked preference for sex, any predominance, however, being in favor of the male. Its incidence in general is estimated at about

4 per cent of all cancers. It conforms to cancer elsewhere in the body in that irritation is the one etiologic factor about which certainty exists at this time. Rectal carcinoma occurs most frequently at the rectosigmoid juncture, a point of marked irritation in the intestinal tract. In this connection the rôle of benign disease of the rectum as an initiative factor and, therefore, as a precursor of cancer, must ever be kept in mind. Prominent among such processes are chronic ulcer, fistulas, fissures, nonmalignant strictures, simple tumors, etc. Any of these may be the starting point of the epithelial proliferation that eventuates in cancer. According to Lockhart-Mummery, in the majority of cases cancer of the rectum begins as a simple adenoma. In fact, he goes so far as to say that "If it were only possible for the rectum to be examined periodically and any simple adenomata removed, many cases of cancer of the alimentary tract would be prevented."

If most of the cases that come to the surgeon are late cases it is because the early symptoms are not impressive. As a rule, when the chief complaint, stubborn constipation, brings the majority of patients to the surgeon, obstruction has already progressed too far to allow complete removal of the neoplasm, and all that can be done is palliative surgery in the form of a colostomy. At the same time the results of this form of treatment are satisfactory as far as prolonging life in comparative comfort is concerned.

The importance of diagnosis thus looms large and justifies detailed consideration. In most cases the history is that of a comparatively prolonged, stubborn attack of constipation occurring a year or so before repeated attacks, or other urgent symptoms cause alarm and induce the patient to seek advice. After the first attack there may be an interval of three to six months of freedom, followed by renewed and more stubborn constipation associated with gradually increasing diarrhea with marked urgency and numerous small evacuations, in reality, constipation or, as it is sometimes called, spurious diarrhea. In other words, a history of alternating constipation and diarrhea in an otherwise healthy person, especially in one past middle life, demands a

rectal examination, since it carries with it the possibility of cancer as the cause of the disturbance, even though objective symptoms are wanting. This is all the more important since one of the characteristics of cancer of the rectum is this latent period after the bowel disturbance has apparently subsided and before the appearance of the significant objective signs of blood and mucus in the stools. Bleeding from the rectum occurs either in the form of hemorrhage or as blood mixed with the feces, while mucus occurs either as slime or casts in the stools. Both these signs, however, are dependent upon the type and variety of the tumor and its location.

The predominant type of cancer of the rectum is adenocarcinoma of the papilliferous or the adenoid or the mucoid variety, the frequency being in the order named. Each of these three varieties may occur at any of the sites: the rectosigmoid, the ampulla, the anal canal (in which cancer develops), and each variety at one or the other site presents certain characteristic features that help to establish the diagnosis. It is a general observation that the most frequent site of rectal cancer is at the rectosigmoid junction. A tumor at this site, especially if papilliferous, rapidly involves the entire circumference of the bowel and produces stenosis. It also causes profuse mucous secretion, often suggesting a mucous colitis, and attacks of progressively increasing diarrhea, occasionally with blood-tinged stools. The diarrhea gradually subsides and is followed sooner or later by symptoms of obstruction due to intussusception of the stenosed portion of the bowel or impacted feces above the stenosis. Pain is not apt to be present.

In contrast to this, in the adenoid cancer obstruction is usually the first urgent symptom without any preceding bleeding or diarrhea. This is explained by the rapid infiltration of the entire circumference of the bowel causing almost complete obstruction and its concomitant symptoms, pain, distension, visible peristalsis, etc. These symptoms, one might say fortunately, are so urgent as to force the patient to seek relief, so that most of these cases are operable when first seen.

The least frequent site of cancer of the rectum is at the

anus. It occurs in this location in only 5 to 7 per cent of the cases. A growth at this site naturally produces early symptoms: pain and bleeding, the latter due to early ulceration as the result of constant friction of the sphincter. The pain attending each bowel movement and persisting for some time after is very much like that of fissure-in-ano, a diagnosis that is often made, especially if the examiner neglects to make a careful rectal examination.

Cancer of the ampulla, intermediate both as to site and frequency, is, comparatively speaking, the most insidious rectal cancer in its onset and progress. This can be explained by the large lumen of the central portion of the rectum and by the fact that its mucosa is less sensitive than elsewhere in the gut. The neoplasm may be present for several months before it manifests itself by the common sign of blood-streaked stools. A papilliferous growth in this location acts much as it does when in the rectosigmoid, that is, gradual invasion of the lumen of the bowel, causing a sensation of fulness in the rectum associated with a sensation of incomplete evacuation of the bowel. This early sign, however, is not present if the tumor is of the adenoid or mucoid variety. These types of neoplasm may exist for several months without giving any signs of their presence, which usually is manifested by a prolonged attack of constipation followed by a latent preulcerative period, and finally by recurrence with the typical diarrhea for which the patient usually seeks advice. There is no pain at this time or, in fact, even later on, until ulceration has taken place; the pain even then is not marked, although loss of weight and more or less excessive bleeding are significant. But, as Miles judiciously remarks, "except in the case of growths situated at the rectosigmoid junction, alternating attacks of constipation supervene only when the disease has passed beyond the stage of operability, and, therefore, if a rectal examination in search of cancer be postponed until this particular sign has developed, a large number of operable growths will be missed."

The importance of a rectal examination is self-evident. While digital examination may suffice when the suspected growth

is low down, it is questionable whether the tumor in its most frequent site, at the rectosigmoid junction, is always within reach of the examining finger. Be this as it may, the findings should be verified by the proctoscope or the sigmoidoscope.

Treatment is surgical. The operability of all cases, however, is another question. Due to the highly insidious nature of cancer of the rectum and the importance of its lymphatic dissemination, most cases (75 to 83 per cent, according to Lockhart-Mummery) come for treatment with the disease well advanced, beyond or almost beyond the stage for successful radical surgery. All that can be done is a colostomy. Colostomy, however, in spite of its unpleasantness, has some advantages. When done early it diverts the fecal matter from the neoplasm, thus removing a constant source of irritation, controls the diarrhea and bleeding to some extent, may even affect the rapidity of the spread of the disease, and by providing for freer evacuation reduces the toxic condition of the patient. Many patients wear the colostomy bag with comfort and perfect cleanliness, grateful for the relief it provides. Furthermore, if done early it is a prophylactic measure which prevents the necessity of using it as an emergency operation when obstruction has advanced and the general condition of the patient is already precarious.

In the past ten years (since the establisment of the follow-up system) a total of 56 cases of cancer of the rectum were treated in our clinic at the Lankenau Hospital. Colostomy was done twenty-three times because of the advanced stage of the disease. There were four operative deaths, three cardiac, and one from peritonitis. One patient, male, aged forty-seven years, is in splendid condition thirty-six months after operation. Twelve patients survived on an average of 10.2 months, the longest posthospital period being twenty-five months and the shortest one month. Of five others who reported to the follow-up clinic two were very comfortable for twelve months and two others in only fair condition seven and five months respectively after operation. All these four failed to reply to various forms of further inquiry. The fifth patient was very well for one year,

but now, twenty months after operation, is in great distress. One patient was never seen or heard from after the operation.

The lymphatic system of the rectum is of utmost importance in the surgical treatment of rectal cancers. The lymphatics present two distinct systems: one in the mucosa and the other between the muscular layers. The systems communicate by a series of short canals which enter the circular muscle fibers. The intramural lymph plexus communicates with the lymphatics of the pelvic colon above and with those of the external sphincter muscle below, and indirectly with the lymph plexus in the skin of the anus and the anal canal, and also with the inguinal and subinguinal glands. Enlargement of the inguinal glands, therefore, is often present and should be looked for when making the physical examination. The intraperitoneal portion of the rectum has a lymph plexus, while a lymph sinus running between the perirectal layer of fat and its external muscular coat supplies the extraperitoneal portion of the rectum. The extramural lymphatic system consists of the anorectal glands of Gerota and an extensive plexus of collecting branches which sends efferent branches upward, downward, and laterally. It is through these efferent branches that cancer spreads outside the rectal wall. The downward branches pass through the layers of ischiorectal fat and thus come in relation with the nodes near the exit of Alcock's canal and finally empty into the internal iliac nodes. Further ramifications and relations with other plexuses establish communications with the retroperitoneal glands, the pelvic mesocolon, the glands at the left of the common iliac artery, the paracolic gland at the mesenteric border of the pelvic colon, and the median lumbar glands. This extensive and intimate lymphatic communication, together with the peculiar circular and longitudinal disposition of the vessels, largely accounts for the rapid extension of rectal carcinoma and its encircling characteristic. If the lymph nodes are extensively involved, early metastasis through the lymph stream is to be expected. Metastasis may also take place through the blood vessels by means of emboli breaking through the portal vein. This explains the frequency of metastasis to the liver.

Operative treatment of rectal cancer naturally takes into consideration not only the site of the growth, but the lymphatic extension of the proliferating process. While the results of surgery are not such as to arouse great enthusiasm, for the present it is the only method that promises relief, for radiation is still less satisfactory. According to Reimann, the pathologist of the Lankenau Research Institute, among the types of malignant tumors which radium does not in any way affect adenocarcinoma stands preeminent. Since this is the predominant type of rectal cancer, we have one apparently good explanation for the inefficacy of radium therapy. The main surgical procedures at our disposal at present, besides a palliative colostomy, are simple excision of the tumor, the Kraske resection of the rectum, the Miles abdominoperineal operation, the Jones modifiation of and more radical than Miles' operation, and Lockhart-Mummery's perineal operation. Each of these has its special indications, and its special advocates, according to the site of the growth, the age and general condition of the tumor. Simple excision naturally applies to the easily accessible tumor at the lower end of the rectum, usually a papilloma. In the Lankenau Clinic series of 56 cases, 10 were treated by simple excision. There was no operative mortality. The patients ranged in age from seventy-eight to thirty-three years, the average age being 53.3 years. The duration of symptoms before coming to operation averaged 21.8 months, the longest period being eight years and the shortest two weeks. Of the ten patients, five required no further treatment. Two are living and well thirty-nine months after the operation; one of these, forty-seven years old at time of operation, is the patient with a history of only two weeks of bleeding from the rectum, attributed to hemorrhoids of long standing; he is now "feeling fine"; the other, with a history of eight years of bleeding and pain from a large protrusion from the anus, has been coming to the clinic regularly for thirty-nine months. She was seventy-one years old at the time of the operation. She still occasionally bleeds from the rectum, but otherwise is remarkably vigorous for a woman of her age. Two other patients are thirty-three and sixty-one years of age respec-

tively; the former reported himself living and well, no bleeding from rectum twenty-four months after operation, but has not been heard from since then. The other one, twenty-six months after operation, was in fairly good health. She had no pain, but was bleeding from the rectum. She was readmitted for further treatment and had a small carcinomatous polyp removed from the rectum. When seen again four months later (thirty months after the first operation) she was still bleeding slightly after each bowel movement, otherwise was in good health. One patient of the series could not be traced.

The radical operations are, all of them, formidable procedures, attended by a rather high mortality, although in the hands of their respective originators, that is, Miles, Jones, Lockhart-Mummery, each claims a comparatively low operative mortality for his particular procedure.

The Kraske resection is based on a procedure introduced by Kocher in 1875 at a time when the advent of antisepsis and asepsis held out a reasonable hope for improved operative results. Before this time surgery of the rectum was not only restricted, but the results were uniformly bad because of the impossibility of keeping the operative field reasonably clean. In the history of the surgery of the cancerous rectum Kocher's method was the first to attain any degree of success. He sewed up the anus and excised the rectum as if it were a closed tube, opened the peritoneum, so that the end of the rectum, and if necessary, even the pelvic colon could readily be mobilized. Kraske extended the procedure by removing the coccyx and part of the sacrum, beginning below the left third sacral foramen. Like Kocher, he avoided disturbing either the anal skin or the external sphincter, and divided the levatores ani close to the rectum, avoiding the pelvic peritoneum, and finally resected the rectum about 2.5 cm. above the tumor, and then brought the proximal end of the severed bowel down and sutured it to the anus, thus providing a new rectum. Modifications of this procedure were devised to provide for easier access to growths higher up by removing wider areas of the bone. These more radical procedures, however, had the disadvantage of weakening

the pelvic floor, and carry with them the danger of septic inflammation of the sacral bone. This last danger was later avoided by various methods of osteoplastic resection of the coccyx and sacrum.

In our series of cases the Kraske operation, with certain modifications, was the procedure of choice in 17 cases. In two instances it was the only operation: one, male, aged thirty-four years, was known to be living and well twenty-four months after operation, but could not be traced after that. The other, female, aged thirty-four years, is enjoying excellent health forty-eight months after operation. Her bowels move regularly without laxatives; she is leading a very active life as a buyer in a large department store. Four patients required a subsequent colostomy, two nine months, one six months, and one twelve months after the resection. Two of these, both females, were enjoying perfect health ninety-five and fifty-two months after the Kraske. The former, forty-one years old at the first operation, had the colostomy done nine months later, and the other, forty-nine years of age, came for the colostomy twelve months later.

Of the other two patients, one a male thirty-three years old, showed signs of recurrence in five months and had the colostomy done nine months after the Kraske. His subsequent history is not known. The other, male, aged sixty-seven years, was reoperated in six months and died seventeen months after the first operation. A fifth patient in the series of seventeen required dilation of a rectal stricture in seven months and died sixteen months after the first intervention. The Kraske was combined with colostomy six times. Three of the patients died while in the hospital, one of heart failure, one of shock, and the third of inanition.

A preliminary colostomy was done in five instances and a preliminary cecostomy once. The latter has never been heard from. Of the former group, one, female, aged thirty-two years, was entirely relieved when seen six months after operation, but later developed recurrent symptoms and died one year after the intervention. The third, female, aged fifty-six years, lived in

perfect comfort for eight months. She could not be traced later until her death, in thirty-three months, was reported to us. There were two operative deaths, one of shock, and one two months after operation of inanition. One patient had a preliminary application of radium. Only five months have elapsed since his operation, but thus far the patient, a male fifty-two years of age, is doing well.

In deciding on the merits of one or another procedure the main point to be kept in mind is the best remote result, that is, preservation of life in comparative comfort. We believe we can make that claim for our Kraske operation. Leaving out of consideration the 5 desperate cases which required a preliminary colostomy, our records show that of twelve patients, five, or 41.7 per cent, are living and leading normal lives at an average of more than four years after operation, and three (25 per cent) were comfortable for at least one year. While we admit the figures are too slight to justify any very definite conclusions, we believe the results justify our preference for this method among the radical procedures.

The Kraske operation as performed in the Lankenau Clinic is as follows: A median incision is made from the promontory of the sacrum to within 2.5 cm. of the margin of the anus, the skin and superficial fascia are reflected laterally, the coccyx, with two or three segments of the sacrum, are removed, exposing the perirectal fat. A bougie is then carried into the anus up to or above the growth and an incision is carried medially, the fat reflected, and the sheath of the rectum exposed. The rectum is now separated from its attachments except above and below, disturbing the levatores ani muscles as little as possible. This dissection, as a rule, is easily made and the bowel readily mobilized, especially if the growth is distal to the rectosigmoid junction. However, if there is invasion of the tissues around the bowel some difficulty may be encountered. In such circumstances careful dissection is required; the rectum below is divided between two clamps and the dissection made so as not to damage either the prostate or the vagina and the bladder. The site of the incision for dividing the rectum is governed by the position

of the growth. When the growth is high up it will be necessary to open the peritoneal cavity in order to bring down the sigmoid so as to get as far away from the neoplasm as possible and to have sufficient bowel to make an end-to-end anastomosis. When the growth is low down the work is much simplified. The union having been made, the colon tube is introduced and fastened to the side of the anus, the wound is packed with gauze and allowed to heal by granulation. These cases practically never heal without the formation of a temporary fistula, which, however, closes in due time and the patient then has full control of the bowel movements.

The operation is done under spinal (spinocaine) anesthesia. For some reason or other these patients are kept under the anesthesia with remarkable ease, compared with some other types of cases. Sometimes gas-oxygen is added when the patient seems nervous or for obvious reasons when it is desirable to discuss the case. The patient is placed on his abdomen resting on pads, the buttock being at the edge of the table, with the feet hanging over the dropped end of the table; the head-end of the table is placed in the Trendelenburg position.

Miles' method in its present development represents the results of years of observation on the incidence, the mode of lymphatic extension, and the site of recurrences. His first operation was restricted to exposing the coccyx, excision of the perianal skin, ischiorectal fat, and dividing the levatores muscles close to their rectal attachment and sectioning the bowel at about 2.5 cm. above the growth. Recurrences occurred in over 93 per cent of cases within twelve months. In later modifications he extended the operation with no better end-results until he finally planned his procedure to include all the tissues within the zone of the paths of extension of the cancerous process—upward, downward, and lateralward. This called for a combined abdominoperineal operation with removal of the following structures: the entire pelvic colon (except the portion needed for the colostomy), the entire rectum included in its sheath of fascia proper, the entire pelvic mesocolon, the peritoneal lining of the floor and the walls of the true pelvis, and a strip of peritoneum

on either side of the origin of the pelvic meoscolon; both levatores ani muscles and as much of the ischiorectal fat and perianal skin as possible. Miles himself calls this "a surgical procedure of the first magnitude and importance," but does not think it too difficult for any one with average surgical skill. He reports a mortality of 10 per cent in his latest series with 29.5 per cent recurrences as against 94.4 per cent recurrences after his former most extensive perineal operation. However, except in his and similarly expert hands the operative mortality is high. Even the most ardent advocates of this radical abdominoperioneal operation recognize it as "a highly specialized procedure," not adapted to general use.

The Jones operation is planned on the same principles as the Miles method, but it is usually done in two stages. The abdominal portion of the operation is the same as in the one-stage method, except that the bowel is not severed, but the upper sigmoid or lower part of the descending colon is brought into the wound for a lateral colostomy. The arches of the vessels of the sigmoid are kept intact in order to supply the bowel below the colostomy. The rectum and most of the sigmoid and its mesentery are placed in the pelvis and are covered with peritoneal fat. The perineal portion of the operation is carried out from five to seven days later. As in the one-stage operation, the rectum is removed from below after the sigmoid is clamped, sectioned, and invaginated at the peritoneal floor. Jones recognizes the unpleasantness of a two-stage operation and also acknowledges the possibility of implantation of cancer cells during the interval between the two operations, due to the dissection of the pelvis and leaving the growth *in situ* for that time. His statistics, however, show that the duration of life is practically the same as for the one-stage operation. In 1922 he reported a 10.6 per cent mortality for the two-stage, and 5.3 per cent for the one-stage, or a combined mortality of 8 per cent. In a later series of twenty-four operations the mortality was nil, six posterior and eighteen abdominoperineal operations. He reports 33 per cent cures forty-nine months after operation, 23 per cent of the total having had metastasis in the regional glands and

the liver at operation Again we must make the comment that this formidable procedure is not adapted for general use, but, like its prototype, is distinctly a surgical specialty. Jones more recently describes a one-stage combined abdominoperineal operation applicable to growths of a certain known grade of malignancy above the sphincter. In this the sigmoid is brought down through the sphincter. He prefers this to end-to-end suture because a greater amount of tissue which may be infected is removed and the bowel is sectioned further from the growth. While interference to the blood supply presents the danger of necrosis, the danger of a fistula is obviated.

Much less formidable and more adaptable to the average case of enfeebled patients that generally comprise the group with carcinoma of the rectum is the Lockhart-Mummery perineal operation. This consists of a colostomy without any dissection, followed a few days or several weeks later by perineal amputation of the rectum and the adjacent zones of downward and lateral spread and the lower part of the upward zone of spread. Lockhart-Mummery claims a mortality of 5 per cent in his most recent series and about 41 per cent of five-year cures, but his figures evidently represent a highly selected group. Be this as it may, the operation is probably the best in most cases of cancer of the rectum in the hands of the average surgeon, since its technic, while not easy, is more readily acquired and consumes less time than the more radical procecures. These advantages naturally redound to the patient in reducing shock.

An operation devised by William J. Mayo in 1912 is of particular value for rectosigmoid growths in very poor risks. In this the sigmoid and rectum together with their mesentery and perirectal fat and the bowel are sectioned below the growth. The proximal end of the sigmoid is brought out for a permanent colostomy and the proximal end of the rectum is invaginated with a double row of chromic catgut; the sphincter is cut with the idea of preventing the collection of secretions in the rectum.

Radium treatment of cancer of the rectum naturally has its advocates, but a review of the literature on the subject reveals a lack of enthusiasm, in fact, a sense of disappointment at the

results, although theoretically the rectum should be ideal for the use of radium. I have already referred to Reimann's explanation of a possible cause of failure of this mode of treatment.

In our series 3 cases were treated by radium. One, a female, sixty-three years of age, is living and well six years and four months after radium treatment; a second, male, aged thirty-eight years, lived for three years and then died of recurrence; and the third, female, aged fifty-eight years, is reported bedfast three months after the application. I mention these cases merely for the sake of completeness and not for any informative value they may represent.

I do not stand alone in advising surgery for all operable cases. Even the enthusiasts for radiation advocate radical surgery as an adjunct to radiation therapy. The operation of choice is a matter of individual preference and experience, especially as to end-results. The great trouble is that too many cases when first seen are already advanced, if not inoperable. Cancer of the rectum can be cured. Of that there is no doubt. But like all malignancy, it must be diagnosed early and treated in its early stage by the most suitable method for each particular case. The fact that surgery, as a rule, demands a colostomy has been held against the surgical treatment of cancer. But I venture to say that a colostomy that can be and is kept clean is much less of a handicap than most people think. To use a modern slogan, "Ask the man who owns one." The day may come when radium treatment will entirely supplant surgery for rectal cancer. But until that time, I repeat, a cure is possible by early surgical treatment of the early case.

BRONCHOSCOPIC AND GENERAL SURGICAL CLINIC OF DRS. CHEVALIER JACKSON AND W. WAYNE BABCOCK

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DIVERTICULOSIS OF THE ESOPHAGUS. ONE-STAGE OPERATION WITH ESOPHAGOSCOPIC ASSISTANCE

IT is desired today to present 7 cases of diverticulum of the hypopharynx from the bronchoscopic clinic for which a one-stage operation has been used. While the one-stage operation, with the technic that we have developed, has thus far been uniformly successful and has saved the patients the many inconveniences, and more disfiguring scar of the multiple-stage operation, it has potential dangers that should always be carefully considered. The single-stage operation may be selected when the operator feels reasonably sure that he can protect the patient against secondary leakage and infection.

Case I.—Mr. S. K. S., age forty-nine years, white, sales manager, admitted January 14, 1930, complaining of regurgitation of food and liquids occurring several hours after meals with the lodgment of food in the throat. There has been no pain on swallowing. The patient for years has been a hasty eater, does not masticate his food well and is accustomed to drinking hot liquids. The present condition began six months ago when, after swallowing a large piece of hot sausage, he immediately had a sensation of discomfort and soreness in the throat. Following this there was increasing difficulty in deglutition with lodgment of food in the throat, followed by regurgitation. For the past few weeks the symptoms have increased in severity, and after retiring at night particles of food are regurgitated.

Roentgen examination (Dr. Manges) revealed a small diverticulum at the level of the seventh cervical vertebra in the midline, holding 15 to 20 cc. of fluid.

Laboratory studies were negative.

Diagnostic esophagoscopy, January 15, 1930, showed the bottom of the pharynx ending in a blind pouch with inflamed and eroded mucous lining; the subdiverticular orifice was over the posterior surface of the cricoid protuber-

ance. A silk thread with attached shot as a guide was swallowed January 16, 1930, and on January 17th Dr. Stull by roentgen examination found the shot at the level of the sacrum.

Diverticulectomy, 1/18/30—external one-stage method with esophagoscopic assistance by Dr. Jackson. Removal of a 4 by 5 cm. sac from the posterior esophageal wall. The sac was not adherent, was 2 mm. in thickness, and food was aspirated from it during the operation. Wound entirely closed except for a small split tube to the esophagus. At the completion of the operation a duodenal tube was introduced into the stomach and brought out through the nose. Three days after operation the small split tube drain

Fig. 513.—Case I. S. K. S. Roentgenogram (Dr. Manges) showing small diverticulum of the hypopharynx in the midline at the level of the seventh cervical vertebra—capacity 15 to 20 cc.

was removed and the provisional suture ligated. Feeding was continued through the tube for ten days, after which liquids, followed later by semisolids, were taken without difficulty. The patient was discharged twelve days after operation, the wound having healed primarily without reaction or leakage. The patient now has complete relief from symptoms.

Case II.—Mr. R. D. F., white, age fifty-nine years, farmer (Canadian), admitted January 21, 1930, complaining of dysphagia, regurgitation of food some time after eating, intermittent huskiness of voice, desire to clear the throat with consciousness of obstruction, and dyspnea while lying down. For many years the patient has noticed that small objects like pills would lodge in the throat for a short time and then gradually pass down. Three months ago an obstruction occurred when the patient attempted to swallow large boluses of food, and there was difficulty in breathing when lying down.

Roentgen examination showed retention of food at the level of the cricoid and on esophagoscopy an obstruction was encountered which could not be passed. The patient was then referred to Dr. Jackson.

Roentgen report (Dr. Manges), January 20, 1930—small diverticulum at the level of the seventh cervical vertebra 2.5 cm. in diameter to the right of the esophageal stream; swallowing function normal and no other gross lesion found in the neck or chest.

Medical and laboratory examinations were negative except for myocardial sclerosis.

Diagnostic esophagoscopy, January 22, 1930, revealed a pulsion diverticulum measuring 2 by 3 cm. when not filled, with an orifice in the hypopharynx. January 23d, a guide thread with attached shot was swallowed. The shot later was located by roentgen ray in the small intestine.

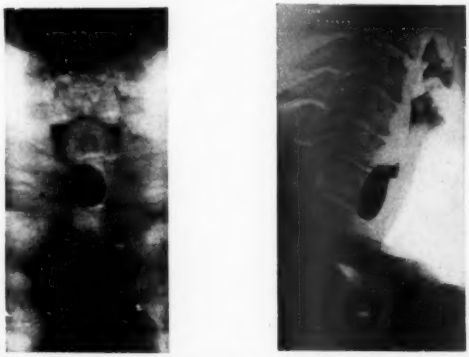

Fig. 514.—Case II. R. D. F. Roentgenogram (Dr. Manges) showing diverticulum of the hypopharynx—about 2.5 cm. in diameter opposite the seventh cervical vertebra.

Operation.—Diverticulectomy, January 27, 1930, external one-stage method with esophagoscopic assistance by the Jackson technic. A thin-walled nonadherent diverticulum containing food, without evidence of inflammation of the sac, was removed. The small split tube drain was removed three days after operation and the provisional suture tied. Postoperative feeding was conducted by a duodenal feeding tube through the nose. The wound healed without reaction by first intention and the patient was discharged symptom free ten days after the operation.

Case III.—Mrs. J. C. P., age fifty years, white, admitted March 17, 1930, complaining of difficulty in swallowing with the lodgment of solid food in the throat requiring forcible regurgitation to obtain relief, dyspnea on exertion, coughing, hoarseness of voice and vascular hypertension. For the past three years the patient has had a nervous irritation referred to the throat after coughing. One year ago food began to lodge in the throat, necessitating immediate regurgitation for relief. During eating audible sounds arise from the throat, embarrassing the patient so that she refrains from eating except in private. A fluoroscopic examination in August, 1929 was negative except

for pause of the bolus in the upper part of the throat, and a diagnosis of cardiospasm was made. In December, 1929, the condition was diagnosed as of mental origin, but a second fluoroscopic examination revealed a diverticulum and the patient was referred to Dr. Chevalier Jackson.

Roentgenograms by Dr. Manges, March 17, 1930, showed a diverticulum of the esophagus at the level of the fifth cervical vertebra, 4 cm. wide, round, smooth, and directly in the midline.

Medical examination indicated neurasthenic tendencies, possibly due to early artificial menopause from the implantation of radium and a marked vascular hypertension. Laboratory studies were practically negative.

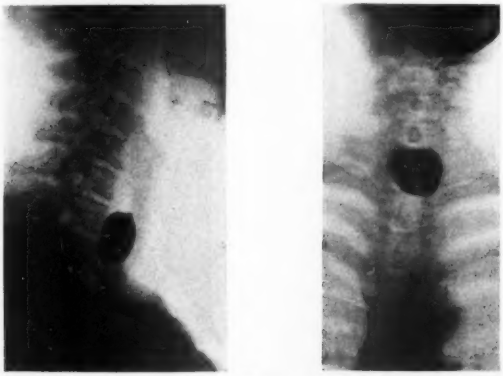

Fig. 515.—Case III. J. C. P. Roentgenogram (Dr. Manges) showing midline diverticulum of the hypopharynx—about 4 cm. in width opposite the sixth cervical vertebra.

Diagnostic esophagoscopy, March 19, 1930, showed a large pouch consisting of almost all of the bottom of the pharynx. The subdiverticular orifice was found on the anterior wall of the hypopharynx. Thread and shot were swallowed March 21, 1930, and the shot was later located by roentgen ray opposite the body of the fourth lumbar vertebra.

Operation.—Diverticulectomy, March 24, 1930, one-stage external method with esophagoscopic assistance by the Jackson technic. As the thread and shot pulled out under traction the esophagoscope was not introduced into the esophagus after the sac was isolated and a feeding tube was not introduced. The diverticulum was thin walled, measuring 3 by 4 cm., and was readily exposed lying to the left of the esophagus. For five days after operation the patient was fed by proctoclysis with glucose and water. The small split tube drain was removed three days after operation and the provisional suture tied. Liquids were swallowed on and after the fifth day. The wound united by first intention without leakage or reaction. Postoperative roentgen report by Dr. Manges: No evidence of diverticulum, swallowing function normal, esophageal contour normal.

Case IV.—Mr. L. J. P., age sixty-three years, white, occupation railroad clerk, admitted May 19, 1930, complaining of a productive cough which had lasted five years, difficulty in swallowing solids for five years, difficulty in swallowing liquids for one year, coughing spells during meals, regurgitation after meals, a constant desire to clear the throat with expectoration of much clear frothy mucus, dyspnea upon exertion and gurgling sounds in the throat. For the past five years swallowed food seemed to lodge in the throat because of the mucus present, and when the patient attempted to clear the throat of mucus the food would be regurgitated. One year ago a sense of strangulation developed on swallowing liquids associated with severe coughing spells and regurgitation of water through the mouth and nose. Gurgling sounds were heard from the throat when taking liquids. The patient has been treated for the cough and expectoration.

Roentgen report, May 13, 1930 (Dr. Stull). Large esophageal diverticulum opposite first and second thoracic vertebra.

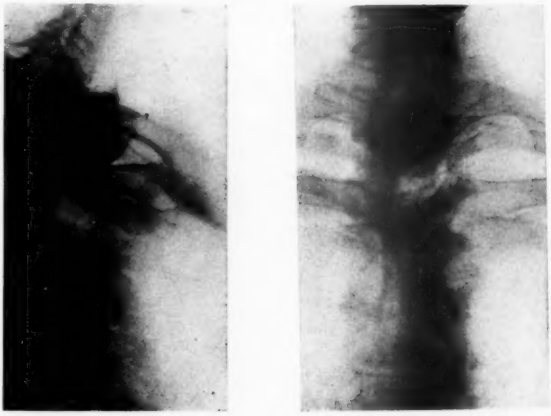

Fig. 516.—Case IV. L. J. P. Roentgenogram (Dr. Stull) showing diverticulum of hypopharynx opposite first and second thoracic vertebrae.

Medical examination, except for thoracic deformity of combined chicken breast and funnel breast type, was negative.

Laboratory studies were practically negative.

Diagnostic esophagoscopy by Dr. Jackson, May 14, 1930, showed a wide diverticulum, slightly bifid, forming an extension from the bottom of the pharynx with a slightly eroded but not ulcerated surface. A shotted thread was swallowed May 20, 1930, and the following day the shot was located in the pyloric end of the stomach, and two days later the shot had reached the ileum.

Operation.—Diverticulectomy, May 23, 1930; external one-stage method with esophagoscopic assistance. Diverticulum with walls 1½ mm. thick ex-

cised. Complete wound closure with exception of small split tube drain. Feeding tube introduced through the nose. Drain removed four days after operation, feeding tube removed nine days after operation, following which feeding by mouth was gradually resumed. The wound healed by first intention and without leakage. Patient discharged as cured eleven days after operation. The cough and expectoration were relieved.

Case V.—Mr. H. B. W., age fifty-one years, retired, admitted May 29, 1930, for regurgitation of solid food, dry cough, thickness of voice and loss of 7 kilos in weight during the past year. There was no dyspnea. The patient smokes excessively and used alcohol freely in his early manhood. He has always been a slow eater, has avoided hot foods, gives no history of having swallowed caustics. The swallowing function was normal until about a year ago, when some delay occurred in his attempts to swallow solid or soft foods. Liquids are swallowed without difficulty. For the past four months there has been regurgitation of food immediately after going to bed, preceded by fulness in the throat and coughing. The returned food is never

Fig. 517.—Case V. H. B. W. Roentgenogram of diverticulum of hypopharynx measuring about 5 x 4 cm.

sour and at times passes out of the mouth on the pillow when the patient lies down during the day time. Thickness of voice has been present for the past year. A diverticulum of the esophagus was shown by *roentgen examination* in May, 1930, and the patient was referred to Dr. Jackson on May 7th.

Roentgen report (Dr. Manges), May 29, 1930, diverticulum of the esophagus at the level of the seventh cervical or first dorsal vertebra, with a sac about 5 cm. in length, nearly 5 cm. transversely and about 4 cm. in an anterior posterior direction. The tip of the sac points toward the left and the esophageal stream flows down nearer the right border of the sac. There is evidence of old tuberculous and calcified glands at the root of the lung.

Diagnostic esophagoscopy, June 11, 1930, showed a diverticulum originat-

ing in the hypopharynx and extending downward about 4 cm. The width of the pouch is about 4 or 5 cm. The sac contains secretion but no food. A swallowed shotted thread was located apparently in the small intestine on June 12th and apparently in the cecum on June 13th.

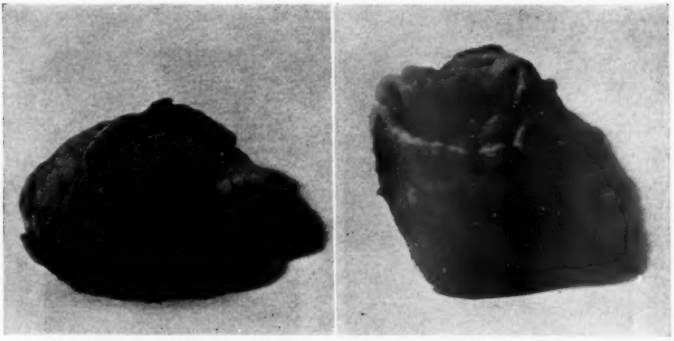

Fig. 518.—Case V. Excised diverticulum of hypopharynx.

Operation, June 14, 1930, diverticulectomy by one-stage method with esophagoscopic assistance by the Jackson technic. Wound closed except for small split tube drainage, small nasal tube introduced to stomach for feeding. Wound healed by first intention and without leakage. Feeding tube removed June 21, 1930, patient discharged June 25, 1930, free from symptoms.

Case VI.—Mr. G. M., plumber, white, sixty-three years, widower, admitted June 9, 1930 complaining of inability to swallow anything but liquids, without pain, but with some regurgitation. Cough for one week and slight hoarseness. Patient has not been a rapid eater nor has he taken hot food. The medical study indicates very rapid loss of weight, evidence of starvation acidosis, and a suggestion of malignant disease. Patient has had an enlarged liver with some jaundice. Present illness began about two years ago with an attack of hoarseness which cleared in about a week and was followed by difficulty in swallowing with lodgment of solid food in the throat. This increased until one week before admission, when patient was unable to swallow even liquids. He has regurgitation of food and liquids, but no vomiting.

Roentgen study showed mass about 1½ inches in diameter in the region of the larynx, moving on swallowing.

Roentgen study (Dr. Manges), June 10, 1930, showed a diverticulum of the esophagus at the level of the seventh cervical and first dorsal vertebra, slightly irregular in shape with a tendency to a double sac formation. There is evidence of a somewhat localized bronchitis and a healed apical tuberculosis. There is a narrowing and irregularity of the upper esophageal lumen.

Operation, June 16, 1930.—After demonstrating the diverticulum through the incision in the neck, the shotted thread is introduced, the esophagoscope passed through the subdiverticular orifice upon the guiding thread revealed a papillary malignant growth of the esophagus extending into the upper mediastinum. The growth was too extensive for surgical excision, the hypopharynx was therefore sutured with resection of the diverticulum and larger drains than usual introduced to the level of the esophageal opening. On

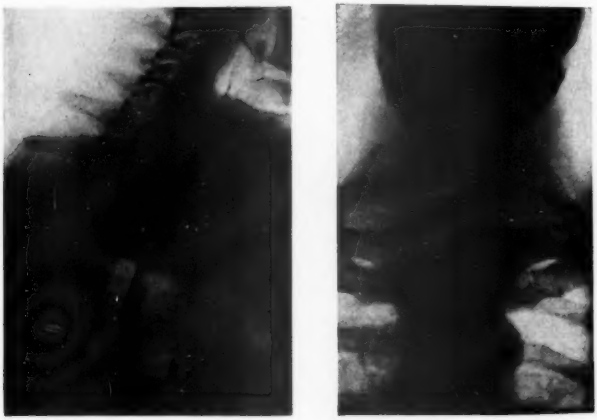

Fig. 519.—Case VI. G. M. Roentgenogram (Dr. Manges) showing diverticulum of hypopharynx with irregularity of esophagus due to carcinoma.

account of the esophageal occlusion due to the carcinoma it was necessary to pass a stiff gum elastic tube through the esophagus into the stomach for feeding. The wound united with a central area of drainage through which there was temporarily a moderate escape of esophageal fluid. Operative recovery resulted, with return of the patient to his home.

Case VII.—A. T. N., male, fifty-six years of age, white, had accidently been struck in the neck by a rope at the age of sixteen and by a slab of wood at eighteen. The present symptoms began in 1914, when a piece of steak lodged in the throat and strangled the patient to a point of unconsciousness. When the muscles relaxed the bolus finally came up. Difficulty in swallowing has persisted since this time. Recently this has increased with greater difficulty in emptying the sac and the patient coughs at night from the lodgment of food. He is able to eat all food and there is no involuntary regurgitation. Wassermann negative.

Roentgenogram (Dr. Manges).—Diverticulum of the esophagus about 5 cm. in diameter about the level of the sixth cervical vertebra. The patient can voluntarily empty the sac of the barium mixture when it becomes dis-

tended with air. *Endoscopy* shows a rather large diverticulum of the hypopharynx with chronic inflammation of the mucous lining.

Operation, July 10, 1930, after the previous swallowing of a shotted thread, one-stage diverticulectomy with esophagoscopic assistance. Wound

Fig. 520.—Case VII. A. T. N. Roentgenogram (Dr. Manges) showing midline diverticulum of hypopharynx from which barium mixture may be involuntarily regurgitated by patient.

closed except for small split tube drain which was removed on the third day. Primary union without leakage, highest temperature 100⅘ F. Uninterrupted recovery. Patient was discharged free from symptoms eleven days after operation.

Comment.—At the beginning of the esophagus opposite the cricoid cartilage there is an area of weakness of the posterior wall. For a space of about 2½ cm. the external longitudinal muscular fibers of the esophagus diverge and pass forward to an anterior attachment to the vertical ridge of the cricoid, leaving a lozenge-shaped area of the hypopharynx unsupported except by a thin layer of circular muscular fibers. Not infrequently this thin wall yields under the repeated stress of swallowing a bolus of food, from failure of the cricopharyngeal pinchcock to open co-ordinately in the deglutition cycle (Jackson). Then there is formed the common pulsion diverticulum of the hypopharynx usually called diverticulum of the esophagus. A second variety of diverticulum, the traction diverticulum, as a rule, develops from the pull of an adherent tuberculous lymph node about the level of the bifurcation of the trachea and is smaller,

much less common and less troublesome. Chevalier Jackson has called attention to a third type, congenital in origin, found in the hypopharynx and in the cervical and thoracic portions of the esophagus. In the pulsion diverticulum the posterior wall of the hypopharynx yields posteriorly and often toward the left side, forming a sac from a few centimeters in diameter to one that may cause a projection on the side of the neck or even enter the thoracic cavity. Ordinarily as in these 7 cases the sac is about the size of an English walnut or an egg. Except at the neck, where a layer of muscular fibers may be present, the sac is usually thin or about 1 mm. in thickness and consists mainly of a smooth lining layer of mucous membrane, covered by a thin external coat of connective tissue.

Etiology.—But one of the 7 cases presented is a woman; 80 per cent of these diverticuli occur in men. The respective ages were forty-nine, fifty-nine, fifty, sixty-three, fifty-one, sixty-three, and fifty-six years. The condition is not common before the age of fifty. The diverticulum may originate from the gulping of a large bolus of food, as with the first patient, who noticed his first symptom after attempting to swallow a large piece of hot sausage. Doubtless an anatomical factor exists in an individual weakness of the supports, but the chief etiologic factor (Chevalier Jackson) is the obstruction ahead of the bolus, due to failure of the muscular pinchcock to open coordinately at the approach of the bolus. The bottom of the hypopharynx is always tonically closed by the cricopharyngeal muscle, just as the buret tube in the laboratory is pinched shut by a pinchcock. Normally, it opens coordinately with the contraction of the inferior constrictor. Two of the patients were well nourished, one being fairly obese. As the condition progresses a reduction in the ability to swallow leads to loss of flesh and strength. The symptoms vary somewhat with the individual patient. Dysphagia, eructation of gas, regurgitation of food, cough, and expectoration of tenacious mucus are common symptoms. As in Case IV the cough and expectoration may lead the attending physician to treat the patient for bronchial or pulmonary disease. Fetid odor to the breath from decomposition of food within the sac and

splashing or gurgling sensation may be annoying. If an external swelling is present, it may be made to disappear by external pressure. None of these seven patients showed this. Hoarseness from pressure on recurrent nerve and Horner's syndrome of unilateral ptosis, myosis or mydriasis, and unilateral flushing, sweating or pallor of the face has been observed, especially if inflammation, ulceration or carcinomatous change has occurred in the sac. In one of this series of cases a carcinoma had developed at the cricopharyngeal pinchcock.

As the patient attempts to eat the sac first fills and only the overflow passes into the esophagus. The patient, therefore, lives upon the overflow from the diverticulum. The mouth of the esophagus may be so narrowed that all food is regurgitated and the patient starve. The diverticulum is, as a rule, readily entered by a bougie, but it may be very difficult, even with the aid of a string guide, to locate and enter the puckered opening of the esophagus. The blind introduction of tube or bougie may perforate the sac and lead to a fatal mediastinitis and, of course, should not be attempted. The esophagoscope in the hands of a trained endoscopist is the only safe method of examination. In esophagoscopic examination a previously swallowed string is used for quickly finding the subdiverticular opening. From the irritation and infection from decomposed food retained in the sac, inflammation, ulceration, perforation or malignant degeneration may occur. The entrance of fetid contents from the sac into the lung may lead to pneumonia or pulmonary abscess.

In examination of the patient anteroposterior and lateral or oblique roentgenograms should first be made after the swallowing of a suspension of barium. The sac should then be carefully inspected through an esophagoscope for ulceration or malignant change.

Treatment.—With a small diverticulum esophagoscopic dilatation of the narrowed mouth of the esophagus and the wearing of an esophageal thread occasionally will give long periods of relief. Usually, more radical measures are necessary. Whenever the sac is so well formed that it holds and retains food, it is such a menace to the health of the patient that it should be re-

moved. The splitting of the common wall between the pouch and the esophagus was used by Mosser in 7 cases, with death in the seventh from mediastinitis. The wall of the sac may be grasped by a forceps, passed through the esophagoscope and inverted into the pharynx. This method, while simple, is not without danger to life; it is likely to be followed by recurrence and it does not always give subjective relief. An external incision is therefore preferred. The danger of leakage and mediastinitis following the operation has led to a very general use of a two- or three-stage operation. In the first stage the sac is liberated, brought to the skin and either opened or left until adhesions have formed. At later stages the sac is either excised or the lining mucosa destroyed by caustic or cautery. The reported mortality from these operations has been about 7 per cent. In 203 diverticuli of the esophagus personally studied by Dr. Jackson and later subjected to multiple or single-stage operation by various surgeons, the mortality has gradually decreased from 10 to 4 per cent or less. It is hoped that with present methods the mortality will be still further reduced. It is our opinion that with a delicate technic it is possible in many cases to do a single-stage operation with a very low mortality and with a great saving in time and disability for the patient. Perhaps final decision as to whether the operation is to be done in one or more stages would be best postponed until the sac is dissected free.

Technic.—The anesthesia has been a combination of local anesthesia with one or more injections of scopolamine, .00065 Gm., and morphine 0.01 Gm., used in conjunction with an enema consisting of paraldehyde 8 cc., Hoffman's anodyne 15 cc., chloral hydrate 1 Gm., and water to make 150 cc. The narcotic anesthesia has the advantage of leaving the throat dry and free from secretion, but it may be associated with an undesirable rigidity of the jaws. Regional infiltration with 1 per cent procaine adrenalin and nerve blocking of the third and fourth cervical nerves at the cervical spines is combined to complete the anesthetic effect. Two or three days before the operation a thread with three or four shot on the end is swallowed as a

guide. The operation is not attempted until the shot are shown by roentgenograms to be in the ileum. A transverse 7-cm. incision is made from the midline of the neck to about the middle of the left sternomastoid muscle, directly over the cricoid cartilage. While this incision gives the operator less room than the conventional incision, it leaves an inconspicuous scar. The skin and superficial fascia and platysma are divided transversely, and the few small vessels encountered are ligated with fine catgut. The left pretracheal muscles with the upper part of the thyroid gland and the adjacent trachea and recurrent nerve are retracted medially, the common vascular sheath of the carotid laterally. The superior thyroid artery and the omohyoid muscle, as a rule, need not be divided. The middle layer of the deep cervical fascia is separated medial to the vascular sheath, the longus coli is exposed beneath the vessels and the left wall of the esophagus reached. This part of the operation which is nearly bloodless and divides no important structures may be quickly and easily done. The sac, as a rule, is not easily demonstrated without the maneuver of Dr. Jackson, who at this stage introduces an esophagoscope into the sac, aspirates any residual liquid or food and pushes the sac up into the wound, where with the light from the end of the esophagoscope it glows like a minature electric globe. In only one of these patients was the diverticulum recognized before Dr. Jackson had demonstrated it by his esophagoscope. The sac is now grasped by forceps and the esophagoscope withdrawn from the sac and, guided by the swallowed thread, is passed for a short distance down the esophagus as a guide to prevent undue constriction of the esophagus in suturing and as a means for aspirating secretions. The sac is now carefully freed from adventitious tissue back to its neck, taking great care not to perforate or lacerate the walls, which often are thin and delicate. With a very fine curved eye or arterial needle traction sutures of fine black silk are placed in the upper and lower margins of the neck of the diverticulum, and with iris or similar scissors the sac is cut away at its neck. The esophagoscope may now be withdrawn. Under the traction the mucous margins remain in contact and are immediately wiped with small

cotton swabs wet with 3½ per cent tincture of iodine. The adjacent wound surfaces are protected by gauze moistened with .5 per cent hydrochloric acid in saline solution to stimulate early plastic adhesion and to prevent infection. With the constant aspiration through the esophagoscope there should be no escape of liquid from the esophagus. With a delicate curved arterial or eye needle and a continuous through-and-through fine black silk suture the edges of the sac are very carefully united with the finesse of an arterial closure. The union should be absolutely air- and water-tight. Care is taken not to explore into the esophagus, nor to crush or traumatize the delicate esophageal tissues.

We believe that an important cause of mortality from the operation has been the devitalization from crushing or ligating the neck of the sac or the crude or imperfect closure of the opening, which has resulted in secondary leakage and infection. The first row of sutures is now inverted by a row of interrupted sutures of fine black silk or No. 000 chromic catgut and the suture lines thoroughly supported by uniting the adjacent esophageal fascia by a third row of interrupted sutures of No. 000 chromic catgut. A small split rubber tube drain is introduced to the side of the esophagus below the line of suture, and the platysma united by fine catgut and the skin by interrupted horsehair.

The points of the operation are the use of a small transverse incision giving an inconspicuous scar, the limited traumatism and exposure of tissue in the wound, the fact that no important structures are divided, the accurate very delicate suture of the neck of the sac, with an anesthesia and technic to reduce the chance of wound contamination. The neck of the sac should not be explored, transfixed, crushed, ligated, or pinched, and the needle used should be so small that leakage through needle holes will not occur. Of the greatest value in facilitating operation, reducing manipulation in the wound, and preventing the escape of esophageal secretions is the associated use of the bronchoscope as developed by Dr. Jackson.

Complications following diverticulectomy that have been ob-

served by Dr. Jackson include injury to the recurrent laryngeal nerve, resection of a part of the wall of the esophagus in mistake for the diverticulum, secondary infection, sloughing, and death from secondary hemorrhage, secondary stricture of the esophagus from removal of an excessive amount of tissue, recurrent diverticulum from removal of insufficient tissue, pharyngeal fistula, infection of the wound and, especially to be dreaded, mediastinitis, which usually is fatal.

At the completion of the operation a small duodenal tube is carried into the stomach and brought out through one nostril. The patient is given a 2-quart enema containing 2 ounces of glucose which under the narcosis is usually retained. Food is given through the duodenal tube every four hours, beginning, if there is no nausea, with water and glucose three or four hours after the operation. If a duodenal tube cannot be safely introduced into the esophagus, rectal or subcutaneous feeding with glucose or lactose solution, using an open ebb-and-flow method, may be employed. If healing without local reaction occurs, the swallowing of small quantities of thin liquids is permitted after the sixth day. The drain is removed at the end of forty-eight hours. The Fowler position is used early and the patient permitted out of bed on the fourth day if there is no unfavorable reaction. With the exception of the patient with the extensive carcinoma of the esophagus, who had more extensive drainage, primary union with little wound reaction has been uniformly obtained, and the clinical results have been excellent in the small series in which this technic has been used. Soft food, such as thin gruels, junket, gelatin, coddled eggs, are permitted after the twelfth day, but the heavier types of food, even if thoroughly masticated, are reserved until at least six weeks have elapsed. If facilities for a very accurate closure of the esophagus without gross contamination of the wound are not available, this type of operation is not advised.

CORONARY AIR EMBOLISM

Case VIII.—*Pulmonary Abscess, Recurrent Hemoptysis with Expectoration of Fragments of Rib Following Empyema and Osteomyelitis of Ribs. Coronary Air Embolism During Operation for Removal of Bone from Within Lung.*—B., male, age twenty-three years. At the age of nine following an injury this patient developed a staphylococcic osteomyelitis of the right femur. This was followed by multiple chronic discharging sinuses of the thigh, ankylosis of the knee, secondary osteomyelitic foci in other long bones, and evidence of amyloid disease. The humerus, clavicle, ribs, and left thigh were involved. At the age of fifteen the patient was referred by Dr. William Schwalm for the closure of the multiple osteomyelitic sinuses of the right femur, which had then persisted despite repeated operations for six years. Protecting the general circulation by tourniquet, the sinuses were sterilized by injecting a saturated solution of zinc chloride, delineated by the injection of a solution of methylene blue and the necrotic tissue, bone, and sinus tracts carefully excised by knife and sharp chisel, as has been previously described (Jour. Amer. Med. Assoc., 1919). The wound was then closed without drainage and aseptic union followed. During the convalescence, however, an osteomyelitis of the ribs and an empyema involving the left thorax developed and required operation. Secondary thoracic sinuses and occasional osseous flare-ups persisted despite various forms of treatment until in 1928, at the age of twenty-one, when after an extensive resection of ribs and removal of sequestra, the patient for the first time in twelve years became free from all external discharging purulent foci. During these years thirty-one operations had been performed and the boy had repeatedly been in a desperate condition. In May, 1928, the patient raised through the mouth a piece of necrotic rib and following this recurrent hemoptysis occurred which in December, 1928 was so severe as to cause him to enter the hospital. For the bleeding, rest in the Fowler position, ice-bags locally and full doses of atropine were used. A free hemorrhage again occurred in October, 1929. In January, 1930 about a pint of blood was expectorated. In February he entered the hospital for another attack of hemoptysis and two minor attacks occurred before he again entered the hospital in April, 1930. During this time, although for the most part the patient was free from cough or expectoration, three small pieces of necrotic rib had been expectorated. Roentgen studies, due to the irregular regeneration of resected ribs, were not elucidative. The patient was in constant fear of death from hemorrhage. Dr. Chevalier Jackson advised against bronchoscopy while there was a tendency to free pulmonary hemorrhage. The wisdom of this opinion was confirmed later.

April 29, 1930, under rectal anesthesia by avertin, the chest was reopened medial to the left scapula in the area of the old sinus tract. A tubular cavity was found about 15 mm. in diameter extending from the pleura to a large bronchus near the hilum of the lung. The cavity was apparently lined by

mucous membrane and contained pus and a small fragment of bone. Near the hilum there could be felt with the finger a fixed fragment of bone, lying upon a large pulsating artery. It was feared that the bone had partially embedded itself in the arterial wall and that an attempt to dislodge it might be followed by violent hemorrhage. For better access the opening at the pleural margin of the lung was therefore slightly enlarged by a scalpel, which divided a small vessel from which blood was feebly ejected in intermittent spurts. This vessel was immediately clamped, but almost instantly cessation of the hitherto excellent pulse occurred, without cyanosis or convulsions and with arrest of the heart in systole. Respiratory movements soon ceased, but by artificial respiration brief periods of voluntary respiratory movement were for a short time produced. Intravenous and intracardiac injections and cardiac massage evoked no response from the firmly contracted heart. The delay occasioned by other resuscitative measures, before the diagnosis of coronary air embolism was made, eliminated any hope of resuscitation by exposure of the heart and aspiration of air from the coronary vessels.

Comment.—*"Pleural Shock." Air Embolism of the Cerebral and Coronary Arteries During Intrapleural Operations.*—For many years surgeons have noted and have feared the sudden death that at times occurs when the pleura or lung is penetrated. It has followed the puncture of the pleura by a needle, the introduction of air into the pleural sac, the irrigation of an empyemic cavity, an operation upon the lung. The older surgeons called it "pleural shock" and warned against the irrigation or manipulation of the pleura. More recently, local anesthetization of the pleura has been advised as a prophylactic measure. The present concept is that under certain conditions air is aspirated into the pulmonary vessels and air emboli passing through the left heart lodge in the cerebral or coronary vessels. Considerable quantities of air may be slowly introduced into the peripheral vessels without the production of symptoms. In a fair-sized dog 60 to 80 cc. of air may be slowly introduced into the femoral vessels without the appearance of dangerous symptoms. A number of times I have injected from 2 to 10 cc. of air into varicose veins of the leg to increase the action of sclerosing solutions without any ill effect. Air bubbles from the peripheral veins pass through the right heart, are filtered out by the lungs, and soon absorbed and do no apparent harm. When a considerable quantity of air rapidly enters a vein close to the right heart, as through a large opening in a vein of the neck,

the air may be churned to a froth in the cavities of the heart, and as the elastic froth is compressed and expanded with systole and diastole, the heart no longer acts as an efficient pump and the circulation is arrested. A great number of air bubbles entering the pulmonary circulation may also block the pulmonary capillaries interrupting the circulation to the left heart, Note, however, that air entering the systemic veins and passing through the right heart is filtered out by the pulmonary capillaries, and unless in considerable quantity may produce no symptoms. Much more serious is the presence of air in the pulmonary veins. No capillaries intervene to filter out the air before it enters the left heart and a few bubbles of air may cause serious symptoms or sudden death by obstructing the cerebral or coronary arteries. There is much more danger, therefore, from air entering the pulmonary veins than from air entering the circulation proximal to the pulmonary capillaries. With the negative pressure upon the pulmonary veins, especially during inspiration, the open vessel tends to aspirate air and the clinical symptoms from the air embolism resulting were formerly interpreted as due to pleural shock. Cerebral air embolism under such circumstances is usually characterized by respiratory failure, cyanosis and convulsions, with secondary failure of circulation, Coronary air embolism causes a sudden arrest of the heart in systole instead of the usual diastole of circulatory failure, with pallor or ashy color, without convulsions, and with secondary respiratory failure. Both are very dangerous, but the coronary occlusion brings a nearly hopeless resuscitation problem. With a heart relaxed and arrested in diastole contraction may be started by the intravascular injection of epinephrine, by cardiac massage, or other measure. With a heart arrested and firmly contracted in systole such stimulative measures are useless. In the laboratory experiments bubbles of air may be seen in the coronary arteries, and by removing these by means of a very fine needle and a small hypodermic syringe the circulation has been restored. It is essential, of course, that the heart does not stop beating more than seven minutes, as in this time the cells of the cerebral cortex essential to life die if unsupplied with blood. In

this patient, unfortunately, seven minutes were used in other resuscitative measures and the necessity of needle aspiration of the coronaries was not realized until too late to be of service. With a primary cessation of the heart during an intrapleural operation air embolism of the coronary veins should immediately be considered. With a primary respiratory failure, with cyanosis and convulsion, during an operation within the chest, the possibility of cerebral air embolism should be considered and artificial respiration and methods to maintain the circulation are needful. Often the patient after minutes, hours, or even a day of coma and paralysis will more or less completely recover. The air has been absorbed from the vessels in the brain and the local circulation is resumed. Even more important is the prophylaxis of air embolism. The lung should only be invaded under conditions that will prevent a negative pressure in the divided veins. This may be accomplished by: First, positive intrapulmonary pressure by inversion of the patient and the use of a face mask or intratracheal tube with the introduction of air or other gas under pressure throughout the operation; second, preliminary ligation or the clamping of the portion of the lung to be incised; third, cautery division of the lung. The cautery is not a positive protection, as in its use veins may be imperfectly sealed against the entrance of air. Only a few days ago, as we were slowly cauterizing without anesthetic a small area in the exposed stump of a lung after a previous partial lobectomy for bronchiectasis, the patient suddenly became faint, then unconscious and convulsed, with dilated pupils, deviation of the eyes, cyanosis, involuntary defecation. Irregular muscular movements continued, and later there was evident weakness of the right side of the body. The coma continued until death about thirty-six hours after the cauterization. In this case slight hemorrhage was observed, but not until after the patient developed the first symptoms. Gauze plugging was immediately used and the gauze moistened with glycerin to more surely seal the vessel against the entrance of air. Evidently air entered the burned vessel before blood began to escape.

Paradoxical breathing is another serious complication of

thoracic surgery which may be briefly discussed at this time. With an open pleural cavity, or after a thoracoplasty under certain conditions, the lung on the affected side expands during the expiratory movement of the thorax and collapses during the inspiratory movement; the air in part at least passing back and forth from the opposite lung. Sucking wounds of the chest and mediastinal flutter may be associated with this movement. In acute empyema, even with closed drainage and often during or after an extrapleural thoracoplasty, the condition may cause a serious postoperative complication. After thoracoplasty paradoxical breathing is to be corrected by splinting the mobilized side by strapping and by fastening the arm to the side. After a tube thoracostomy serious symptoms are prevented by clamping the tube to better immobilize the lung and mediastinum, until physiologic adjustments have taken place; just as all sucking wounds of the chest should promptly be plugged or closed. Not a few patients who have died of supposed shock after thoracic injury or operation have died from the lack of attention to paradoxical breathing which has been permitted to continue.

KRUKENBERG TUMOR WITH MASSIVE HYPERPLASIA OF BREASTS

Case IX.—Mrs. H. P., age fifty years, colored, referred by Dr. Frank Boston. Illness began in August, 1929, with loss of weight, appetite, and strength, dyspnea, enlargement of the breasts, especially the right, abdominal enlargement, dysuria. The patient was able to work until April, 1930; her previous weight was 230 pounds and she has lost 80 pounds in nine months. The right breast shows whitish scars from previous ulcers and is so large

Fig. 521.—Case IX. Massive enlargement of breast from metastatic Krukenberg tumor. The primary growth was in the stomach and the left ovary was also involved.

and heavy as to be greatly in the patient's way when lying, sitting, or standing. The abdomen was distended by bloody fluid and diffuse peritoneal malignancy was found on a limited abdominal exploratory operation. The patient died from the progress of the disease June 6, 1930.

Comment.—This patient entered the hospital solely for the removal of large heavy discommoding breasts. On examination hemorrhagic ascites due to peritoneal carcinoma was found. The patient was in very poor condition from advanced malignant disease, and only palliative and diagnostic measures were used. The necropsy by Dr. Konzelman revealed a much contracted stomach containing a carcinoma with the characteristic mucoid degeneration and signet ring cells of the Krukenberg tumor. Similar growths, evidently metastatic, were found in the left ovary and the right mammary gland.

About 80 cases of Krukenberg tumor have been reported. The primary growth in the stomach or other part of the alimentary tract is usually small and unrecognized during life, attention being first directed to the ovarian metastasis. In this case metastasis to the mammary gland occurred with such massive enlargement that the patient asked to have the breast removed. The case is presented on account of the diagnostic features and the rarity of the disease.

ACHOLIC HEPATITIS. CESSATION OF BILIARY FUNCTION OF THE LIVER FROM CHRONIC OBSTRUCTIVE JAUNDICE FOLLOWING CHOLECYSTECTOMY

Case X.—Mrs. X. Z., white, age twenty-seven years, had severe gallbladder colic at the age of twenty. Two years later, after a second severe attack, a cholecystectomy was done. The operation is said to have been complicated by severe hemorrhage from two anomalous arteries, a violent anaphylactic reaction from a blood transfusion, pulmonary congestion and, seven weeks later, an empyema requiring costatectomy. Three months after the cholecystectomy, as fulness and distress in the upper right abdomen persisted and the incision continued to drain freely, the patient entered a second hospital where a large gauze pad is said to have been removed. The

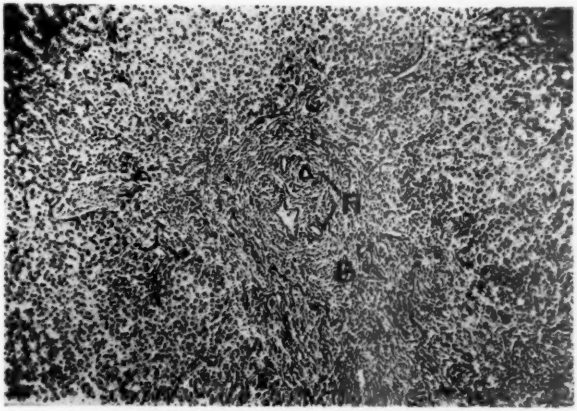

Fig. 522.—Case X. Acholic jaundice after cholecystectomy showing proliferation of fibrous tissue about the bile ducts at A and irregular proliferation of duct epithelium at B (Dr. F. W. Konzelman).

patient was confined to bed for seven months. She was admitted to this hospital May 14, 1930, having had intermittent attacks of jaundice with or without chills and fever and clay-colored stools for two years. For the past two months the jaundice has been permanent, the stools have been clay-colored constantly, the urine bile-stained. The blood shows hemoglobin 38 per cent, reds 2,400,000, whites 5950, polymorphonuclears 39, small lymphocytes 55, platelets 380,000, calcium 15, coagulation time 7.5, hardly improved by daily intravenous injections of calcium chloride. Transfusion

was refused by the patient, as she had nearly died from a previous one. In May, 1930, under spinal and local anesthesia, the old scar was excised, adhesions separated, and a careful search for the hepatic and common ducts made well into the separated notch of the liver. The exposed ducts were small,

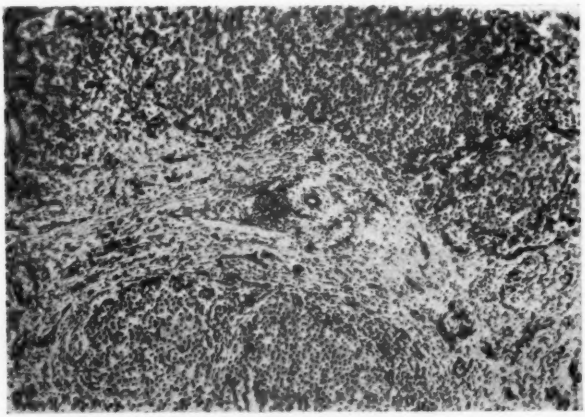

Fig. 523.—Case X. Acholic jaundice. Nodular collection of mononuclear cells in the vicinity of a bile duct (Dr. F. W. Konzelman).

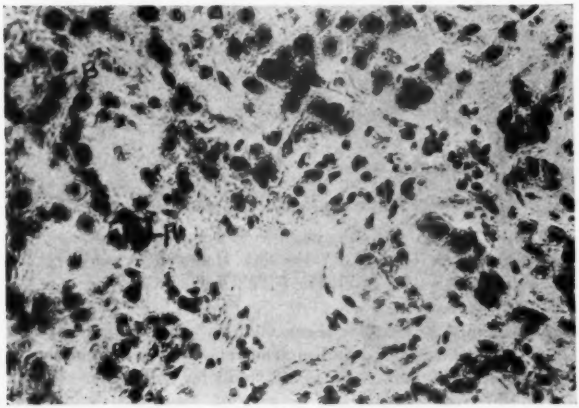

Fig. 524.—Case X. Acholic jaundice. Region of central vein in liver showing fibrous thickening of wall of the vein, with fibroblasts and leukocytes. At A there is a mass of inspirated bile in a biliary capillary. At B a distended biliary capillary contains granular material (Dr. F. W. Konzelman).

empty, and on exploratory probing not a trace of bile was found. On incision the slightly enlarged and blackish green liver showed no bile staining. The contemplated anastomosis of bile ducts to the duodenum was impossible, the liver had ceased to secrete bile. An irremediable and hopeless condition was present. The patient passed through the operation in fairly good condition, but some hours later died. The removed liver showed no evidence of bile. A pathologic study by Dr. Konzelman showed marked biliary sclerosis and no evidence of recent bile formation.

Case XI.—Mrs. M. B., age fifty-five years, at the age of forty-eight, after eighteen months of recurrent biliary colic, had a cholecystectomy for a mucopurulent cholecystitis and cholelithiasis. During the operation a rent was made in what was supposed to be an hepatic duct. A catheter was introduced into the duct and a biliary fistula with absence of bile from the stools continued until October, 1922, when the patient was referred by Dr. J. N. Coombs for operation. After delineating the sinus by injecting a solution of

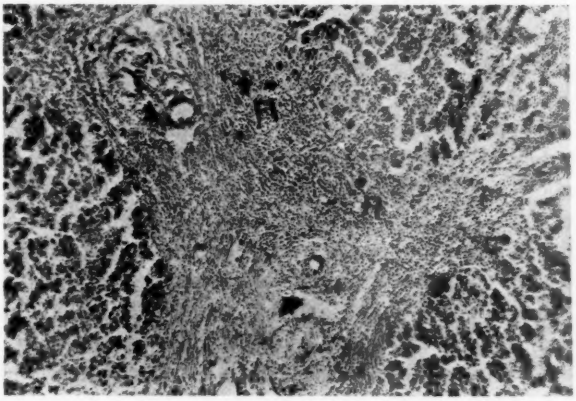

Fig. 525.—Case XI. Acholic jaundice showing interlobar fibrosis. The bile ducts have largely disappeared, but inspissated masses of bile are found lying in ductlike spaces at A. Note diffuse cellular infiltration (Dr. F. W. Konzelman).

methylene blue, it was dissected free at the outer part and anastomosed into the first part of the duodenum. The immediate result of the operation was satisfactory. There was no further external discharge of bile. A number of months later, however, indigestion and attacks of colic with some jaundice recurred. The jaundice finally became persistent and intense and the patient gradually failed and died about seven years after the cholecystectomy. Necropsy showed a granular pigmented deposit in the biliary ducts which were collapsed and free from bile.

Comment.—Here are two tragedies due to cholecystectomy. The great potential dangers of this operation have not been sufficiently emphasized. Hundreds of serious accidents are unrecorded—accidents which are not uncommon with the tyro in biliary surgery, but which also occur at the hands of the expert surgeon. What surgeon of experience has not had them? The first cholecystectomy was by a surgeon of large experience who had devoted years to the study of the biliary tract, yet violent hemorrhage during what promised to be a simple operation upon a thin young woman nearly resulted in a death upon the operating table, led to a number of dangerous postoperative complications and at last to adhesions that obstructed biliary flow and finally obliterated all biliary secretion. The second accident was probably due to the inexperience of an operator doing one of his first cholecystectomies. The first lesson is that with or without experience and skill the operation of cholecystectomy should not be regarded lightly. The second lesson, and this comes to me personally at this time, is not to delay reoperation when jaundice occurs after cholecystectomy or an anastomosis for biliary obstruction. To save the liver from an irretrievable loss of function I should have urged operation for the first patient when the jaundice returned, and the formation of a new anastomosis between the bile ducts and the gastro-intestinal tract. In obstructive jaundice the operator expects to find dilated or thickened bile ducts. That he may find empty atrophic ducts, useless for purposes of anastomosis, is shown by the above 2 cases. With obstruction of the ureter two things may happen. If the obstruction is complete and permanent, urinary excretion ceases and degeneration, atrophy, and permanent loss of function of the kidney occurs. If the obstruction is partial or intermittent, the type of urinary excretion may be modified, but the pelvis of the kidney and the proximal portion of the ureter usually show marked dilatation and hyperplasia. Similar changes occur in glandular organs having ducts. For example, ligation of Steno's duct has been used to arrest the function of the parotid gland. This secondary loss of function is not generally appreciated in regard to liver. These cases illustrate that a fatal

suppression of biliary function may follow an obstructive jaundice. Dilated ducts or ducts containing bile were not demonstrated at the operation or at the autopsy, and in the first patient not only did no bile escape on cutting into the liver during operation, but on blotting the cut surface no yellow staining was observed. The condition is a lamentably hopeless one. It emphasizes the importance of early operative relief for obstructive jaundice and the desirability of reoperations should obstructive symptoms develop after operations involving the biliary ducts.

ARTERIOVENOUS COMMUNICATION BETWEEN THE FEMORAL ARTERY AND VEIN. INCREASE IN SYMPTOMS, HEMORRHAGES AND THREATENED GANGRENE FOLLOWING THREE OPERATIONS INCLUDING LIGATION OF THE FEMORAL ARTERY AND OF THE VEIN. QUADRUPLE LIGATION AND EXCISION WITH GREAT IMPROVEMENT; SECONDARY TROUBLESOME VARICES RELIEVED BY SCLEROSING INJECTIONS

Case XII.—C. D., male, age twenty-three years. In 1923 when the patient was sixteen years old an automatic pistol he was carrying in his front trouser pocket discharged, the bullet passing through the left thigh. An arteriovenous aneurysm formed for which an operation was done. A year later the leg was swollen and cyanotic and a hemorrhagic ulcer had formed at the junction of the middle and lower third of the leg. At a second hospital two operations were performed with increase in the symptoms and four hemorrhages from the ulcers of the leg have occurred. In November, 1923 the patient entered the Temple University Hospital. The left leg was greatly swollen, cyanotic, and ulcerated. There was marked pulsation extending from the middle of the thigh to the toes. The patient had been unable to walk upon the leg since the second operation. The left border of the heart was 2.5 cm. lateral to the midclavicular line, the right border about 12 mm. lateral to the right sternal line. The apex beat was in the fifth interspace. A marked bruit could be heard and felt most intensely over the middle of a 12-inch oblique scar on the medial side of the left thigh.

Operation, November 26, 1926, spinal anesthesia, excision of old scar, arteriovenous varix between femoral artery and vein excised. Evidence found of previous ligation of femoral artery proximal to the opening and of the femoral vein distal to the opening. The leg which was about three times the normal size had reduced one half at the completion of the operation. The patient had an uncomplicated convalescence and was discharged on the tenth day after operation. In May, 1930 the patient returned, complaining of pain and swelling in the legs on exertion, due to large varicose veins. There was no evidence of an arteriovenous communication. Under sclerosing injections of bichloride of mercury, and quinine and urethane, without confinement to bed, the condition has rapidly improved, and as you now observe the patient is able to walk about without discomfort and the leg, although pigmented, is free from swelling.

Comment.—This case well illustrates operative errors not infrequently made in treating arteriovenous communications,

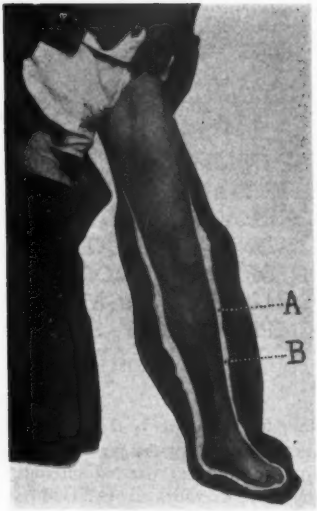

Fig. 526.—Case XII. Arteriovenous communication from gunshot wound of the thigh, the dark area illustrating the enormous swelling of the leg following ligation of the femoral artery and vein: *A*, The residual swelling from varicose veins after radical excision of the aneurysm, and *B*, the final condition, after injecting sclerosing solutions into the veins.

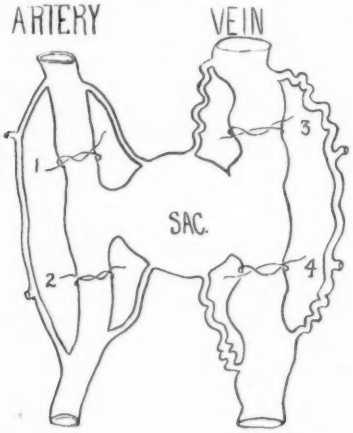

Fig. 527.—Case XII. Diagram of arteriovenous aneurysm showing collateral circulation and illustrating why the symptoms in this case were not improved by a ligation at 1 and increased by a ligation at 4. It is obvious that the condition would not be relieved by ligations at 1, 2, 3, and 4.

from a failure to appreciate the hydrodynamics of the condition. Side-to-side arteriovenous communications result in dilatation of the communicating veins with or without the production of a true or false intervening sac. Endothelium from the vein soon lines the communicating channel, so that coagula within the sac or in the dilated veins are unusual. There is little tendency toward spontaneous cure. The arteriovenous fistula causes a marked fall in blood pressure and a decrease in pulse rate (Branham's bradycardia). These factors together with the greatly increased capacity of the dilated veins result in a compensatory increase in the total blood volume and an enlargement of the heart, as is well shown in this patient. From the larger fistulas a dilatation of the heart which progresses to myocardial failure is not unusual. Lariche and Stulz have shown that even after closure of the fistulous opening, the enlarged heart does not return to normal. It is evident, therefore, that the abnormal communication should be eliminated as soon as possible to prevent serious damage to the heart. An end-to-end communication of an artery and vein lying in the direction of vascular flow is not, however, followed by enlargement of the vein or artery, nor does it appear to produce a strain upon the heart. This type rarely results from accident. The local symptoms of a side-to-side arteriovenous communication are a thrill and bruit, which are most intense during systole and directly over the site of the lesion. When the fistula is closed by digital compression there is a transient rise in blood pressure and fall in pulse rate. Blood removed from the tributary veins shows of course a relatively high oxygen content. The affected limb increases greatly in size. The temperature of the part is higher than normal near the fistula and lower distally. The veins greatly dilate and thicken, their valves become incompetent and they carry a marked pulsation to the fingers or toes. Varying degrees of pain are present, and as the normal circulation is reversed by the forcing back of the venous blood in the veins, degenerative and fibrotic changes occur and may result in ulceration, hemorrhage, necrosis, and gangrene. If, as in the patient presented, the artery is ligated proximal to the anastomosis, arterial blood

entering the artery by collateral channels distal to the opening passes in the line of least resistance, back into the veins through the false opening and returns to the body. The limb, therefore, is continuously bled of arterial blood, the veins continue to engorge, and the venous circulation is largely blocked. Obviously the tendency toward gangrene is increased by the ligation. A single proximal ligation of the involved artery, therefore, should never be used. The ligation of the vein distal to the opening is also without merit, owing to the widespread venous anastomoses.

The prognosis of the condition without operation is unfavorable. While rarely with a small fistula spontaneous closure may occur in the early months, the tendency is to enlargement of the opening, progressive embarrassment of circulation, and finally death from failure of the dilated heart. The perforation of a small aneurysm of the base of the aorta into the contiguous descending vena cava may even be followed by death from cerebral change in seven to nine days.

The ideal treatment of an arteriovenous communication is to separate the artery and vein, carefully close the two openings by suture, and to interpose a layer of living soft tissue between the vessels to prevent recurrence. Matas suggested that the opening be exposed by an incision in the vein, closed by suture, and the edges of the opening in the vein finally united. Another method is to resect the involved portions of the artery and vein with end-to-end arterial and venous anastomosis. As a rule, these more ideal methods are difficult or not very feasible in the individual case, and the usual operative treatment has been a quadruple ligation of the artery and vein, the ligatures being placed above and below the point of anastomosis with excision of the sac or communicating channel. Especially if an aneurysmal sac is present, quadruple ligation alone may be insufficient, as it may not occlude all channels. An endosaccular exploration, endoaneurysmorrhaphy, has advantages. In any case complete hemostasis as by an Esmarch bandage is very desirable. Excision has given satisfactory results and, as Makins has emphasized, there is less danger of gangrene when the vein as well as the artery

is ligated than when the artery alone is tied. It should be remembered that the elimination of a fistula may precipitate cardiac decompensation from overdistention of an already dilated heart so that the surgeon, during the course of the operation, should be prepared for a prompt venesection to remove the excess of blood which has accumulated in the body during the period of existence of the fistula. As the diastolic pressure increases after closure of the fistula, prolonged care to prevent secondary myocardial strain is also advisable.

To avoid infection and possible secondary hemorrhage three months if possible should elapse after closure of the original wound before the operation is attempted. At times, to avoid delay, a granulating wound surface may be sterilized, as we have previously described, by a saturated solution of zinc chloride, excised, and the operation then completed without infection and with little delay.

The possibility of residual disability from the great dilatation of veins and their incompetent valves is well illustrated in this patient. Sclerosing injections here proved very helpful. To obliterate varicose veins we have for a number of years used with satisfaction a 1:1000 solution of bichloride of mercury. If not over 10 cc. (0.1 Gm., $\frac{1}{6}$ grain) of the bichloride are used at one time, no ill effect from the mercury is to be expected. Unless leakage outside of the vein occurs the injection is painless and the secondary local reaction is mild in character. For the larger veins 1 cc. of a 1:100 solution of the bichloride may be injected under protection of elastic bands. For huge veins the quinine-urethrane solution (quinine hydrochloride 0.26, urethane 0.13, distilled water to make 2 cc.) is a more powerful coagulant, but produces a more intense secondary reaction. From 0.25 to 2 cc. are injected.

HYPEREXTENSION OF HAND AND FINGERS FROM A BURN. CORRECTION BY A SINGLE PEDICLED SKIN AND FASCIAL FLAP FROM ANTERIOR ABDOMINAL WALL

Case XIII.—Miss M. K., age thirty-two years. In February, 1929, while working in a laundry, the left hand and forearm were caught in an automatic electric presser producing a third-degree burn involving the dorsum of the hand and forearm. This injury resulted in a broad keloid scar extending from the upper third of the forearm to the fingers. By cicatricial contraction the hand and fingers were hyperextended at a right angle to the forearm, the wrist was fixed, two fingers were partially dislocated. With the exception of limited movement in the little finger, the patient could not move the fingers. A limited degree of abduction of the thumb was present. In September, 1929 excision of the scar with plastic sliding of the adjacent skin reduced, but

Fig. 528.—Case XIII. Single pedicled flap from abdomen to hand for deformity and dislocation of two fingers due to the deep scars from a burn.

did not overcome, the deformity. By persistent elastic traction the wrist became straight and 20 to 30 degree extension and flexion were obtained. There was no motion in the proximal joints of the fingers and the hand remained useless as far as work was concerned. In April, 1930, the scar was excised and a large broad flap pedicled above raised from the upper abdomen and sutured over the defect. The flap united perfectly and the pedicle of the flap was divided in about ten days.

Comment.—Deep burns involving the back of the hand are not unusual in laundresses, who have their hands caught be-

tween the heated rollers of a mangle. The extensor apparatus of the fingers and hand usually is involved and the joints may be invaded. The elasticity of a large thick pedicled flap from the abdomen may be utilized to replace the destroyed tendons, restoring by its elasticity extensor power to the fingers. We have also seen motion return even to the small opened joints of the fingers under such a flap. In this case the extensor tendons were not destroyed, but were unable to properly function under the scar.

PIGMENTATION OF THE FACE FROM THE INSTILLATION OF ARGYROL IN THE CONJUNCTIVAL SAC

Case XIV.—Miss M. G., age twenty-one years, had a right-sided dacryocystitis at the age of six which was treated by incision and the instillation of argyrol. After several days a large dark stain was observed on the lower lid, which has persisted without apparent change for the past fifteen years.

Fig. 529.—Case XIV. Illustrating the pigmentation of the skin of the face from the use of argyrol in the treatment of dacryocystitis.

Comment.—This patient with the large bluish pigmentation of the right lower lid illustrates the danger from instillation of silver preparations into the conjunctival sac or in wounds about the face. The oxydized silver may be permanently fixed in the skin and subcutaneous tissues. The patient gives the appearance of a chronic "black eye." By tattooing with certain destructive chemicals, which already has been tried in this case, the superficial particles may be removed and the intensity of the discoloration reduced. The pigment, however, lies deep in the subcutaneous fascia and for complete obliteration of the stain

we will infiltrate the subcutaneous tissues with a 1 per cent solution of procaine, excise the pigmented portion of the skin of the lower lid and, with wide undercutting to avoid tension or extropion, slide the adjacent skin margins over the pigmented subcutaneous tissue and unite them by interrupted sutures of fine horsehair. To avoid the lachrymal duct we will not attempt to excise the deeper pigmented tissues.

Note.—Part of the stitches were removed on the third day and part about the sixth day, and a nonpigmented linear scar remained.

CLINIC OF DR. JOHN H. JOPSON

DR. NORMAN S. ROTHSCHILD, ASSOCIATE SURGEON,
GRADUATE HOSPITAL, UNIVERSITY OF PENNSYLVANIA

OPEN SAFETY PIN IN FOURTH PORTION OF DUODENUM

THIS patient, Y. S., ten months old, was referred from the Chevalier Jackson Bronchoscopic Clinic of the Graduate Hospital with the history of having "swallowed" an open safety pin on July 30, 1928. The open pin went on down the throat and her mother noticed some redness around the eyes, as though there was some slight discomfort in swallowing the object. A physician was consulted, who suggested a "dry diet," which would probably help in the passage of the pin. This was of no avail. Five days after the accident an *x*-ray examination revealed what was diagnosed as an "open safety pin in the stomach about one inch above the navel." This diagnosis was made from films showing the anteroposterior view only. At weekly intervals *x*-ray examinations were made showing the pin in the same position. No symptoms developed except cough and the child seems to be perfectly normal and healthy. The child was then sent to Dr. Jackson with the above diagnosis.

x-Ray examination on September 24, 1928 at this hospital by Dr. J. G. Cohen revealed an open medium-sized safety pin in the duodenum just at the duodenojejunal junction, the clasp pointed cephalad and the spring caudad.

On September 26, 1928, Dr. Cohen reported: "Examination made today reveals the safety pin to be practically in the same identical position as examination of the films shows that were made August 4, 1928, elsewhere. These findings would indicate that there has been no change in the position of the pin since the first examination (Fig. 530)."

On September 28, 1928, under ether anesthesia, an upper right rectus incision $2\frac{1}{2}$ inches in length was made into the peritoneal cavity. The stomach and transverse colon were lifted upward, the duodenum was located and the pin palpated in its distal portion just proximal to the duodenojejunal flexure. The first portion of the jejunum was drawn forward and to the left, a thin veil of peritoneum was divided at its base to partly

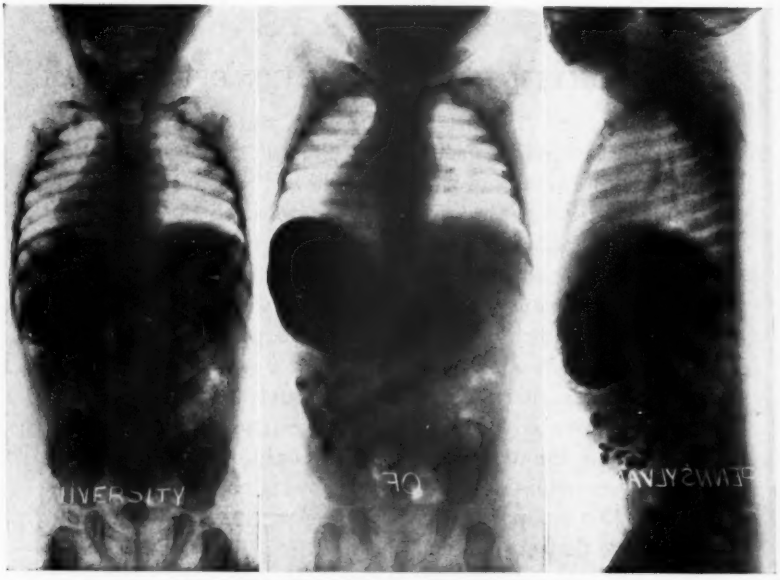

Fig. 530.—*x*-Rays of safety pin in the duodenum.

mobilize it, the pin was coaxed downward by gentle manipulation into the jejunum, 3 to 4 inches below its junction with the duodenum. The pin was then snapped shut in the unopened bowel, its closed end pressed against the wall of the intestine. A fine linen purse string suture was inserted into the wall at this point. The wall was nicked over the pin, which was extracted with forceps and the purse string suture tied. Another transverse line of fine linen suture was applied over the opening in the bowel. The abdominal wound was closed without drainage.

Postoperative convalescence was uneventful and the patient was discharged fifteen days after operation.

Three points may be stressed: First, repeated *x*-ray examination, in two planes, anteroposterior and lateral, were necessary to determine the exact location of the pin. Although it was thought to be in the stomach before admission to this hospital, this was definitely excluded by our *x*-ray examination, and its correct position determined. Second, the longer an object, as a pin, remains in the intestinal tract, the greater is the probability of it causing ulceration and perforation. This is especially true if it is lodged. This is a real danger, as Dr. Jackson stressed in this case. Third, the removal of the pin should be done through the jejunum, if the pin be in the duodenum, because of the difficulty of approach to, and exposure of the duodenum in its retroperitoneal portion, and the possibility of a duodenal leakage resulting from an opening in this region.

CHRONIC EMPYEMA TREATED BY THE MULTIPLE STAGE (KELLER) METHOD

THIS patient, B. B., nineteen years old, was transferred from the Jackson service with the following medical history: Four years ago patient had pneumonia, which was followed by an empyema of the left pleural cavity. Two years later she developed an empyema necessitatis pointing in the third interspace, 1 inch to the left of the sternal border. Resection of the eighth rib, posterior, axillary line, was performed then. How long it drained the patient is unable to say.

On examination, the patient is a thin, white female, weighing 72 pounds, the picture of a victim of long-standing suppurative process. The chest is badly deformed with a marked retraction of the left side. Thoracotomy scar at left base. Anteriorly a draining sinus in the third interspace 1 inch from the left sternal border. Expansion of the left chest is practically absent. Tactile fremitus absent posteriorly and over lower half of anterior chest. Percussion note over left lung, flat, except at left upper anterior portion which shows dull tympany (compressed lung). Breath sounds absent over flat area. Harsh bronchovesicular sounds over compressed lung. Right chest shows dull percussion note, harsh bronchovesicular breathing and many râles from apex to base. Posteriorly, below the angle of the right scapula is an area of either consolidation around a terminal bronchus or a small cavity. The heart is markedly displaced to the right. The apex is found in the fourth interspace, the right border is 10 cm. to the right of the midsternal line. The left border could not be determined. Muscle quality toxic; no irregularity; no murmurs; pulmonic second sound accentuated.

Abdominal examination shows slightly enlarged liver, probably amyloid. The kidneys and spleen could not be palpated. The fingers and toes were markedly clubbed.

The blood count showed a moderate anemia, while the urine

was negative. A smear from the sinus of the empyema necessitatis showed nonhemolytic streptococcus and Bacilli coli.

x-Ray examination by Dr. J. G. Cohen was as follows: "There is an empyema of the left pleural cavity with very marked thickening of the pleura, compression of whatever lung structure there is left, mostly in the upper lobe, and deviation of the heart, trachea, and mediastinum to the right. There is also probably a purulent bronchitis of the right lower lobe bronchi. There is

Fig. 531.—Chronic empyema before operation. The heart is in the right side of the chest.

a section of the rib removed from the ninth rib posteriorly in the midaxillary line, approximately 6 cm. in length. There is a small amount of air present also in the lower portion of the left pleural cavity. There is a swelling just to the left of the lower portion of the sternum, which has probably resulted in an osteomyelitis of the sternum, but which we cannot demonstrate roentgenologically (Fig. 531)."

This type of chronic nontuberculous empyema has been treated by us by the method described by Col. W. F. Keller. It is a graded operation, combining the advantages of this type of operation with open treatment of the infected cavity, Carrel-Dakin sterilization, plus blood transfusion, heliotherapy, etc., as indicated.

It is done in multiple stages: The first stage consists of resection of one or two ribs in the posterior axillary line with exploration of the empyema cavity. Pockets are broken through

Fig. 532.—The drainage tube and Dakin tubes in the cavity.

and allowed to drain into the main cavity. Tubes are inserted into the cavity and the cavity is dakinized (Fig. 532). Smears and cultures are taken at intervals and when the bacterial count has fallen to a low level, and the patient's condition is favorable, the second stage operation is performed. This consists of the resection of the ribs which form the roof of the cavity, removing from 6 to 8 cm. of each rib. The muscles covering the ribs are

first dissected free by a curved incision of the overlying tissues and the edges of the skin are sutured over these muscles to protect them, leaving the cavity exposed. The cavity is then packed with Dakin gauze. This is removed in forty-eight hours, Carrel-Dakin tubes are inserted, and dakinization is again started. This is continued until bacterial count is again low. Blood transfusion and other appropriate measures are used as indicated. *x*-Rays are taken at various times to give additional information as to lung expansion and sinus contraction. The third stage consists of the release of the muscles, freeing the skin which has been sutured to the muscles, and decortication of the lung in some cases. The muscles are allowed to drop into the cavity and are sutured to the lung if possible. The skin is closed with but a single rubber tube drain.

At times this technic has to be modified. The second stage, the resection of the ribs forming the roof of the cavity, may have to be done at two or more sittings because of the condition of the patient. All the operations are started under local anesthesia and are usually supplemented with gas and oxygen. Blood pressure estimations are made at frequent intervals during the operation.

On April 1, 1929, the first stage was performed. The ninth rib in the posterior axillary line was resected and a large amount of pus evacuated. The old anterior sinus was explored by probe and found to communicate with the main cavity. One fenestrated rubber tube was inserted into the cavity.

On June 8, 1929, the sixth, seventh, and eighth ribs were resected for a distance of 6 cm. in the lateral area. The muscles were retracted and the skin sutured over the muscles. This protects them from infection and fibrosis. The cavity was treated by dakinization.

Figure 533, *x*-ray examination on August 21, 1929, after the injection of a sodium iodide solution and with the patient in the erect and Trendelenburg position, showed a chronic empyema cavity in the left chest, being about 20 cm. long and about 3 cm. in the transverse diameter and 4 cm. in the horizontal dimension. The parietal pleura over the entire left lung was very

thick. There had been a very notable decrease in its size since the previous examination.

On September 23, 1929, the remaining portion of the roof of the cavity was removed, the muscles released, the lung partially decorticated and the skin freed from the muscles and sutured. One rubber tube drain was used. The patient reacted very well

Fig. 533.—This *x*-ray was taken in the Trendelenburg position. The lower portion of the cavity contains air.

from the operation, but remained in the hospital until the Christmas holidays. She had a small sinus at the site of drainage with very little discharge.

She returned on April 6, 1930, and on April 14th the small fistulous tract remaining at the drainage opening was excised and the wound sutured. The wound healed without complica-

Fig. 534.—*x*-Ray showing complete obliteration of cavity.

Fig. 535.—As patient appears today.

tion and the patient was discharged on May 11th (Figs. 534, 535).

It is well recognized that in these cases of chronic nontuberculous empyema that the compressed lung will rarely expand because of the dense adhesions and that obliteration of the cavity, with or without preliminary and continuous sterilization, is the only method of cure. There are of course several well-recognized standard methods of accomplishing this end. The method we have briefly sketched, embracing the principle of operation in several stages, graded to the strength of the patient and permitting discontinuance at any time, is of life-saving importance. For a full appreciation of the problem and the methods employed to meet it one should study the contributions which Col. Keller has made on this subject.

CARCINOMA OF THE COLON TREATED BY THE MIKULICZ TECHNIC

Case I.—Male, forty years, transferred from the service of Dr. George Morris Piersol, with chief complaint of weakness. He stated that five months before admission he had taken some epsom salts and had a watery stool containing blood. This was not repeated and no medical aid was sought. A month later he suffered an attack of grippe from which he never entirely recovered. Two weeks after the grippe and because of the weakness, he consulted a physician. A peptic ulcer was suspected and he was placed on a diet for three weeks. There was no improvement. With exertion he complained of dyspnea and vertigo and a tightening sensation in his abdomen. In the past three months he has had intermittent diarrhea. There is no history of loss of weight.

Physical examination reveals a well-nourished male, who is exceptionally pale. The abdominal examination reveals a hypersensitive area in the epigastric region, but no palpable tumors. After the bowels had been cleansed by purgatives and enemas, a tumor mass was palpable in the upper portion of the umbilical region, a little to the right of the midline. The blood count was hemoglobin 55 per cent, red blood cells, 4,000,000. The stools were repeatedly positive for occult blood. The *x*-ray examination revealed a carcinoma of the transverse colon in the midportion. Repeated blood counts showed a progressive anemia; other laboratory findings were negative.

The history of diarrhea and the progressive anemia made one consider the diagnosis of tumor of the large intestine, in the ascending or transverse colon, which was verified by the *x*-ray findings (Fig. 536).

After the customary preparation and colonic irrigations for two days, the first stage of the Mikulicz operation was performed on April 1, 1929. In all our cases the bowel has been resected after mobilization as part of the first stage. The ends are approximated by lateral suture, and a Paul's tube is inserted into the proximal loop of bowel and the distal loop is closed by a purse string suture of silk. These ends are well above the surface of the skin, the Paul's tube is connected with rubber tubing, which drains into a large vessel.

Twenty-four hours after this operation the patient developed acute dilatation of the stomach with vomiting of considerable quantities of brownish material. A Jutte tube was immediately passed into the stomach and the patient, who was very cooperative, drank as high as 7 quarts of water in twelve hours. The intake and the output from the stomach were carefully measured and in order to prevent alkalosis normal saline, 1000 cc., was given hypodermically every six hours. After twenty-four hours the distention and vomiting had ceased. Small quantities of water were given and retained. The Jutte tube was clamped and finally withdrawn after forty-eight hours. The patient's general condition was excellent.

Paul's tube was removed in six days. Bowel movements were occurring daily through the proximal loop. Daily irrigations of the bowel were made. Two weeks after the first stage a Dupuytren's clamp was applied to the spur and in five days it was destroyed. Six weeks after the first operation closure of the colostomy was performed. There was slight leakage from the wound, which had been adequately drained. Four days later the patient had bowel movement per rectum. The discharge from two small sinuses in the wound

Fig. 536.—Showing the involved portion of the transverse colon.

varied at times, but eventually ceased and the wound healed. *x*-Ray examination, before discharge from the hospital, showed the anastomosis quite adequate for a free and uninterrupted passage of the colonic contents. The caliber at the anastomotic ring is about that of the adjacent portion of the colon. The pathologic diagnosis was adenocarcinoma, without glandular metastasis. The patient remains in perfect health and has been examined recently in this clinic.

Case II.—Female, age fifty-seven years, was admitted to the service of Dr. H. L. Bockus with the chief complaint of diarrhea. Patient stated that

she was well until two years ago, when she had several rather severe hemorrhages from the bowel. Some weeks later she had another hemorrhage, followed by diarrhea. Diarrhea was associated with gripping pain and has persisted until the present time. She has five to eight movements a day associated with severe burning. No severe hemorrhage had occurred since the onset of the diarrhea. She has not lost any weight. Examination revealed a fairly well-nourished female, showing a moderate anemia. The abdomen showed no evidence of obstruction by way of distention. There is a small, hard, movable tumor palpable just above Poupart's ligament on the left side. There are no palpable inguinal nodes. There is no evidence of malignancy elsewhere.

Laboratory examinations showed a moderate anemia, the urine negative, the stool plus four for occult blood. *x*-Ray examination revealed a filling defect at the rectosigmoid junction, this corresponding to the palpable mass in the abdomen.

All the unobstructed tumors of the bowel receive castor oil, followed by enemas on the two following days, as part of the preoperative preparation.

The first stage of Mikulicz was performed on August 10, 1928, under gas and oxygen anesthesia. The liver was found to be negative for metastasis. The lymph nodes in the mesosigmoid were enlarged and firm. After well mobilizing the bowel, the sigmoid and mesentery were resected. The tumor partially obstructed the lumen. Before removal, however, the peritoneum was closed and sutured to the bowel wall. A Paul tube was inserted into the proximal loop of bowel while the lower loop was closed by a purse string suture.

Thirteen days later a Dupuytren clamp was applied to the spur and removed in six days when the spur had been cut through. Two days following there was a bowel movement per rectum. This has been noticed frequently after destruction of the spur. Daily irrigations of the bowel with normal saline were resumed and one month from the first operation the second stage of the Mikulicz was performed. The prolapsed portions of the bowel were resected along with the scar tissue of the wound. The bowel edges were brought together by interrupted sutures of catgut. This line of sutures was reinforced by sutures bringing serosa to serosa. The peritoneal cavity was then opened and the bowel dropped back. The peritoneum was then sutured and the wound closed, draining the fascial space. Her recovery was uneventful and the patient was discharged three weeks after final operation.

Pathologic diagnosis: Adenocarcinoma.

This patient has shown some evidence of metastatic involvement of the liver for the past three months and exhibits loss of weight. She must be classified as probable recurrence.

Case III.—Male, age fifty-nine years, admitted to Dr. Jopson's service with the history that for the past year and a half he has had attacks of abdominal pain, associated with vomiting and obstipation. These attacks occur about once a month. Pains are severe, lasting for a few minutes, then followed by a rumbling sensation in the lower abdomen, which brings relief.

Pain occurs in both sides, formerly the left, lately in the right. The abdomen becomes "hard" during the attacks. The last attack started five days before admission and was severe, associated with heart burn and vomiting, which gave relief. However, the pain persisted. Patient has vomited variable amounts daily. The vomitus is brown and sour, never fecal. Red bloody stools were noted occasionally. Tarry stools frequently follow attacks. His physician stated that he has been suffering with stones in the bladder and had 1 per cent sugar in his urine and 180 blood sugar two years ago.

Physical examination on admission revealed a well-developed male, abdomen scaphoid, no masses palpable. Peristalsis active but not hyperactive. The abdomen is somewhat tender to palpation. The evening of the day of admission the patient became distended; the distention was more marked on the right side, which came up under the hand in waves and felt like distended cecum.

This subacute obstruction responded to repeated high compound enemas and the patient's condition permitted studies to be made. The abdomen became flat and flaccid. A small hard sensitive mass could easily be detected in the upper left quadrant.

Laboratory examination showed negative urine, normal blood sugar and normal blood. *x*-Ray findings were as follows: First examination failed to see barium enter any portion of the large bowel. Second examination, after a compound enema, the barium filled the dilated rectum, where it is distinctly delayed and slowly fills the area about 3 inches above the crest of the ilium, in the descending colon. Patient examined twenty-four hours later, after the barium by mouth, showed an obstruction in the descending colon, no barium being noted in the rectum. Previous films taken at another hospital and diagnosed negative show the same deformed lower portion of the descending colon. This emphasizes the importance of repeated *x*-ray studies in order to confirm the diagnosis of a tumor of the large bowel.

He was operated upon on October 28, 1927, and a large napkin ring tumor of the descending colon 4 inches below the splenic flexures was found. The liver was negative for metastasis. The first stage of the Mikulicz operation was performed and Paul's tube placed in the proximal loop. The patient's condition on the table was serious and stimulants were resorted to. An exceptionally long spur was produced and it required the application of a clamp twice until it was destroyed. The third stage of the operation was performed six weeks after the first. At times there was a moderate amount of leakage from the suture line, but it became less and the patient was discharged three weeks following the closure. The sinus closed up shortly thereafter.

This patient presented the symptoms of subacute intestinal obstruction, which responded to enemata and allowed him to be adequately prepared for operation. The characteristic sign of severe sharp and lasting pain, which is relieved by the passage of intestinal content and gas through the site of the incomplete obstruction, was present in this case.

Pathologic diagnosis: Adenocarcinoma.

This patient remains well at the present time.

Case IV.—Female, age thirty-nine years, was admitted to the service

of Dr. G. M. Piersol with the history that for the past year she has been very constipated and has had several attacks of lower abdominal pain associated with vomiting. Four weeks before admission she had a severe attack of pain in the lower left quadrant associated with vomiting. The pain was very severe, colicky in character, and required narcotics for relief. The vomiting continued for four days. The patient failed to regain her strength after this attack. Two days before admission she had a second attack of lower left quadrant pain with distension and vomiting. Pain was not so severe as in previous attack, but moved from the lower left quadrant to the umbilical region, where its greatest intensity is at present. Patient has been obstinately constipated for over a year and she has lost 7 pounds in the year.

Fig. 537.—*x*-Ray showing the site of the acute obstruction at the rectosigmoid.

Physical examination revealed an undernourished, anemic, and somewhat toxic-appearing white female, who has the definite odor of acetone on her breath. The abdomen is markedly distended and tympanitic. Hyperperistalsis is present. The temperature, pulse, and respirations are normal. The urine was negative while the leukocyte count was 16,350.

Figure 537, *x*-ray examination by flat plate and barium enema, was reported as follows: abdominal film shows very marked distension of the entire large bowel and some of the coils of the small bowel with distinct dilatation of the descending colon. Barium enema shows dilatation of the sigmoid and terminal descending colon. There is an abrupt stop near the junction of the sigmoid and descending colon. We are dealing with an absolute obstruction at this time.

"The study of the history and examination of the patient suggests a chronic obstruction in the lower bowel, which has recently become complete. The history shows repeated attacks, during the last year, of abdominal pain, colicky in nature, accompanied by vomiting and associated with marked constipation. Four weeks ago she apparently had a temporary complete obstruction similar to present attack, which yielded to medical treatment. Present attack five days in duration associated with repeated vomiting, marked abdominal distension, visible peristalsis in the distended coils, hyperperistalsis on auscultation, constipation, all pointing to a low intestinal obstruction. The barium enema I think confirms this diagnosis and locates the obstruction at the junction of the sigmoid and descending colon. Operation will, in all probability, be necessary. I would advise first, two high-compound enemas with three-hour intervals, to see if temporary relief can be obtained; if successful, patient can be better prepared for ordeal of operation, which will probably be a two- or three-stage one, if growth be present and permits of removal, and if metastasis is not present; otherwise, colostomy should be performed. If one or both of these compound enemata are not successful, operation should be promptly performed, preceded by gastric lavage and hypodermoclysis or intravenous glucose or saline, or both."

The enemas were not successful and the patient was operated upon at midnight, January 31, 1928. Under gas and oxygen anesthesia a left rectus incision was made into the peritoneal cavity. The napkin-ring growth in the descending colon was located and delivered into the wound. The large bowel proximal to the obstruction was distended and appeared like a distended balloon. Clamps could not be applied to it because of the size and fear of tearing. It was brought onto the abdomen and punctured; fortunately, it contained only gas. After it had emptied itself, clamps were applied and the first stage of the Mikulicz operation was performed. The patient went into profound shock on the table and further exploration of the abdominal cavity was not permitted. She responded from the shock and her condition gradually improved. Sixteen days later Dupuytren's clamp was applied to the spur and six days later it was completely destroyed. The closure was performed twelve days later and the wound healed without any leakage. Pathologic diagnosis: adenocarcinoma.

The subsequent history of this patient is of great interest. She was operated upon by Dr. Jopson at the Presbyterian Hospital in June, 1928, for a carcinomatous cyst of the left ovary, and in February, 1929, at the Graduate Hospital for a similar lesion in the right ovary. Following the last operation *x*-ray treatments were instituted. Examinations of the abdomen on these occasions showed ample lumen of the resected bowel and no evidence of recurrence at that point. Her present condition is excellent and from the report of her physician there is no evidence of the return of malignancy in the abdomen.

Comment.—Cases I and II presented the chief symptoms of diarrhea and anemia, while the obstructive cases presented constipation as their symptom of longest duration associated

with colicky pain. It is now well recognized that tumors of the large bowel from the cecum to the splenic flexure normally give the history of diarrhea associated with a progressive anemia and those below the splenic flexure, constipation with or without anemia.

While we have performed the Mikulicz operation in each case because we feel that the extraperitoneal resection lessens the possibility of a peritonitis. We appreciate that primary cecostomy followed by resection anastomosis will unquestionably lessen the period of hospitalization. In Case IV we would at the present time believe it better judgment to perform a cecostomy as the first step, and thereby relieve the obstruction. The choice could then be made as to resection and suture, or Mikulicz technic in treatment of the tumor generally speaking. While the former is the popular procedure, there is much to be said in favor of the Mikulicz procedure in the non-obstructed type. We have employed it for some years with much satisfaction.

One point in the technic is that immediate removal of the tumor mass takes place after loops of bowel have been sutured together and the peritoneum sutured to the bowel. This removes any possibility of recurrence of the growth in the wound from prolonged contact with the original tumor. The degree of mobilization and the extent of resection we employ is equally as free as if we proposed to proceed with immediate anastomosis by suture.

CLINIC OF DR. JOHN BERTON CARNETT

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SO-CALLED "SUBACROMIAL BURSITIS"

THE affection usually designated subacromial bursitis is a very common one and presents a distinctive clinical picture, but fails to be recognized by the majority of general practitioners. Its presence should be considered in every case of acute or chronic pain and stiffness of the shoulder. Often the pain extends to the elbow or to the hand and fingers in the form of a brachial neuralgia. The most common cause of brachial neuralgia is subacromial bursitis. In cases of brachial neuralgia or neuritis due to other causes the arm can be freely abducted at least passively if not actively. In bursitis abduction and internal rotation of the arm are always limited or painful or both. The maximal pain is usually located over the outer aspect of the lower part of the deltoid muscle. Tenderness, as a rule limited to an area no larger than a silver quarter dollar, is located at some point just beneath the anterior edge of the acromion process. In the great majority of the cases presenting marked symptoms a calcareous deposit is present at the site of the localized tenderness. This deposit can be shown by roentgenograms which must be taken either stereoscopically or else in both positions of extreme inward and extreme outward rotation of the humerus; otherwise many deposits will fail of detection.

In two earlier papers[1, 2] I have discussed the etiology, symptoms, diagnosis, and treatment of this affection at considerable length and will not repeat those details today.

The calcareous deposit in these cases very exceptionally may rupture into the bursa, but I have never seen one at operation other than on, in, or under the tendon of the supraspinatus

muscle. The majority of writers, through faulty observation, describe the position of the deposit as being in the bursa or in the bursal wall. It is most important for you to remember that the deposit is always outside the bursa—beneath its floor—otherwise you are apt to miss finding it in the cases you subject to operation. I believe the lesion which gives rise to the symptoms is in the tendon rather than in the bursa because in many of the operative cases the bursa is found entirely normal.

Many of the writers on bursitis ascribe the lesion to a minor strain or injury which causes a rupture of a few fibers of the supraspinatus tendon with the formation of a blood clot in which the calcium is deposited, but I believe the deposits as a rule are quiescent in their formation due to a tendonitis, local necrosis of tendon, and calcification produced by oft repeated occupational traumata squeezing the supraspinatus tendon between the tuberosity of the humerus and the acromion process or acromioclavicular ligament. In my opinion, the deposit antedates the trauma which often inaugurates the symptoms which may be mild or vicious in onset and may pursue either a chronic or an acute course.

Mild symptoms may persist for many years. An acute primary attack or an acute exacerbation in a chronic milder case is commonly but not invariably followed in a few weeks to a few months by spontaneous absorption of the calcareous deposit probably due to the increased blood supply of the acute inflammation. I have had a number of these deposits under observation for years and I have never seen one disappear spontaneously in the absence of acute clinical symptoms.

The treatment of these cases may be either operative or nonoperative. Patients anxious to return to work at the earliest possible date usually elect operative treatment. Women who object to an unsightly scar and prefer enduring a few weeks of pain and disability select nonoperative treatment. Practically all patients ultimately recover irrespective of treatment or lack of it, but their nonoperative recovery may be delayed for months or years.

I have discussed the operative treatment of excision of the

deposit in my former papers and today I want to demonstrate to you a patient treated without operation.

This patient is now forty-eight years of age. She came to me four years ago, at the suggestion of her husband who is a physician, to have a small fibroma removed from her left axilla under local anesthesia. Because of a little difficulty she then had in abducting her left arm to expose the axilla she explained that she had been having a "touch of rheumatism" in her left shoulder for the previous two years. She almost never had any spontaneous pain when the shoulder was at rest, but efforts at elevation and internal rotation of the arm were a little restricted and were somewhat painful in the shoulder region. Other movements were entirely free and painless. She has continued to have the same symptoms in the left shoulder up to the present time. On examination of the shoulder four years ago, she exhibited the same area of tenderness she has today just beneath the acromion process at the greater tuberosity of the left humerus.

I made a diagnosis of bursitis and made arrangements for roentgenograms to be made of both shoulders the following day. I have found that about one out of every three patients having unilateral symptoms will show deposits in both shoulders. The pictures in this instance revealed bilateral deposits. They were shown to the patient's husband and he reported to the patient concerning them before she returned to my office. When she did come in next she brought her husband's mother and his sister with her and stated she believed they both had the same trouble. They both had seen several physicians, but no one had suggested bursitis. Skiagrams of their shoulders proved positive for calcareous deposits. Three patients in one family having bursitis simultaneously illustrate how very commonly this affection occurs.

This patient never had any symptoms in her right shoulder prior to Friday, February 7, 1930. On that date she stood on a chair to remove a heavy framed picture from the wall. In easing it to the floor she strained both shoulders. She slept very little that night because of pain in both shoulders. Pain

in left shoulder gradually subsided and disappeared in three days, but pain in right shoulder was progressively worse and kept her awake all of Saturday night. Sunday morning she called in Dr. Truman G. Schnabel and later in the day I saw the patient with him.

Pain then was absent in left shoulder, but was exquisite all the way from the neck to the hand on the right side. She refused to permit any movement of the shoulder. There was a small area of localized tenderness just below the front margin of the acromium process. The diagnosis of acute bursitis was obvious. The arm was placed in a sling and instructions were given a nurse to administer ample opiates to control the pain. I saw the patient again on Tuesday, at which time she requested operation because her pain was intolerable. Hypodermics of morphine, however, blunted the pain, but provoked vomiting. Thereafter codeine and aspirin were substituted with better results. The pain was better on Thursday and spasm of the shoulder muscles had largely subsided. On that day Dr. W. M. Brickner of New York happened to be in Philadelphia and I asked him to see the patient with me. Up to this time the patient's arm had been held in moderate abduction by a fat pillow placed between the arm and side of the chest. Dr. Brickner applied a loop of towels from the head of the bed around the patient's arm just above the elbow to bring the arm into wider abduction. The following day, Friday, the pain was much less severe and I could elevate the arm straight upward from the shoulder with very little increase in pain. Thereafter the arm was allowed to hang at her side, but was brought into full abduction for a moment twice daily to combat contractures of the shoulder muscles which might otherwise occur. Unfortunately this patient's spine was not sufficiently flexible to permit her to bend over and touch the floor with her finger tips while standing with knees fully extended, or we would have had her carry out that painless maneuver to secure full abduction as first described by Dr. A. E. Codman of Boston.

By Saturday the patient had improved so much that she was able to go to a roentgenologist to have pictures taken of both

shoulders. Unfortunately, the roentgenograms of four years ago had been lost, but judging by the records of her case there has been no change in the appearance of the two separate deposits in her left shoulder (Fig. 538), but the single deposit in her right shoulder was considerably larger as shown by the picture (Fig. 539) taken on February 15, 1930.

Two weeks after the onset of acute symptoms, pain had completely disappeared from the right shoulder, but movements of

Fig. 538.—Two deposits in left shoulder. February 15, 1930.

the arm, especially elevation or internal rotation, caused pain. In the next three weeks all movements became free and practically painless. Today, as she expresses it, she "barely feels" any abnormality in the extremes of internal rotation and abduction on the right side. On the left side she has moderate pain while the arm is being carried either upward or downward through the 65 to 80 degree arc of abduction. Circumduction of the arm at shoulder level causes the most distress, but it is

Fig. 539.—Right shoulder. February 15, 1930.

Fig. 540.—Right shoulder. February 24, 1930.

Fig. 541.—Right shoulder. March 4, 1930.

Fig. 542.—Right shoulder. March 14, 1930.

not very severe. Subsequent roentgenograms (Figs. 540–542) disclose gradual absorption of the deposit in the right shoulder. By exercising the imagination one can detect the barest trace of the deposit in the films of March 25th, but even that trace had disappeared ten days later. The deposits in the left shoulder remain unchanged.

This case demonstrates several points characteristic of so-called "bursitis." The deposit in the right shoulder was known to have been present nearly four years before it caused any symptoms whatsoever. A slight trauma then precipitated an acute attack. In the reported cases, other than mine, roentgenograms had not been taken prior to the attack and it was assumed in each instance that a mild trauma similar to the one in this case had torn a few fibers of the supraspinatus tendon with the formation of a small hematoma and early deposition of lime salts—the latter being found when the first pictures were taken some days after the injury. My custom of having both shoulders roentgenographed even when all the symptoms are confined to one shoulder reveals many cases of deposit in the symptomless shoulder and in many of them symptoms have first developed following a trivial injury as in this patient.

In my experience spontaneous absorption of a deposit only occurs after an acute attack as in this patient's right shoulder. The physiotherapists who have reported cases of absorption of deposits under diathermia treatment, all ignore the possibility of spontaneous absorption and give the entire credit to diathermia. In a considerable experience with diathermia I find it commonly eases pain temporarily, but I am convinced it does not hasten absorption. I have had it tried on symptomless deposits without benefit. The diathermists must cause absorption of quiescent deposits before they can substantiate their claims of causing absorption of deposits giving acute symptoms.

This patient's left shoulder is a typical example of long continued—six years—mild symptoms without alteration in the deposits during the past four years.

I have recently operated on a case of parathyroid tumor with high blood calcium with loss of bone calcium. That case suggests

the possibility of administering the active hormone of the parathyroid to expedite or cause absorption of calcareous deposits as they would probably yield more readily than the bones to a blood-calcium hunger.

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CHRONIC ANAL SPHINCTERISMUS AS A CAUSE OF CONSTIPATION

UNDUE tightness of the anal sphincter is a frequent cause of chronic constipation. This fact is commonly mentioned in text-books on Proctology, but it is not sufficiently emphasized. It is a rare event for a general practitioner to give any thought to the possibility of constipation being due to a tight sphincter.

My own attention was first directed forcibly to the importance of sphincterismus years ago in a series of patients with acute painful fissure in ano on whom I dilated the sphincter under nitrous oxide anesthesia. The dilatation not only cured the fissure, but corrected the constipation of many years' duration. I then sought for any subjective symptoms which might indicate that constipation was due to an abnormally tight sphincter and found two that are fairly constant. It is very seldom that patients volunteer statements as to these two symptoms, but appropriate questions promptly elicit the desired information. Practically all of them take cathartics or diets that result in a soft mushy stool and they then have no difficulty in expelling the stool. The two characteristic symptoms result when they have neglected their usual precautions. The first symptom is their feeling of a firm mass just within the sphincter which they have difficulty in expelling. The second principal symptom is the diminished caliber of the constipated stool. These two symptoms are the outstanding ones indicative of the constipation being due to a tight sphincter, but on questioning one or more additional symptoms may be found in some instances. A small percentage of patients have learned to aid the expulsion of the stool after it has started through the sphincter by fingers applied in a stroking movement from the coccyx toward the anus thereby exerting pressure on the stool through the soft tissues. An occasional patient gives a history of repeated impactions in which he has had to insert a finger into the rectum to break up the stool

before it could be passed. Many patients state that experience has taught them that if their first efforts at expulsion of the fecal mass felt low in the rectum are futile then further efforts will prove useless and they resort at once to an enema. Very exceptionally a patient with the most marked degree of sphincterismus states that he is never able to pass anything except a liquid stool and frequently or always resorts to enemas. Some patients give a history of pain or of blood-streaked stools indicative of past or present fissure in ano.

All individuals pass a small calibered stool when the feces are soft, but when the feces are very hard and firm the patient with a tight sphincter passes a stool of lessened caliber—about the diameter usually of his thumb or exceptionally of his middle finger. In a few of these patients the stool is broken up into small balls. The usual cause of the narrow ribbon-shaped stool formerly ascribed to cancer of the rectum is a tight sphincter. Only in the exceptional instances of early cancer confined to the anal canal does cancer cause that type of stool.

Physiologists tell us that the sausage shape of the stool is acquired in the sigmoid where the feces are usually retained until they pass into the rectum and create the desire to go to stool. Any one at all familiar with rectal examinations is well aware of the fact that the finding of feces in the lower rectum in the absence of any desire to go to stool or even shortly after defecation is a very common event. Furthermore, a large quantity of feces in the rectum assumes the shape of a ball rather than a sausage. This is shown by skiagrams as well as by the palpating finger. In my opinion, the sausage shape of the stool is determined by the sphincter and the caliber of the stool by the consistency of the feces and the tightness of the sphincter. Either soft feces or a tight sphincter will result in stools of small caliber.

The subjective symptoms of (1) difficulty of expelling feces which can be felt in the rectum and (2) the passage of small calibered firm stools should be substantiated by the objective finding of a tight sphincter before ascribing constipation to this cause. Digital examination by means of a well-lubricated gloved finger by an examiner familiar with the normal tonus of this

muscle promptly discloses the undue spasticity characteristic of sphincterismus. Existing fissure or a slight scar from a previous fissure is often found, as associated fissure is a common cause of sphincterismus and a tight sphincter predisposes to fissure. In many cases, however, no irritative lesion can be found to account for the sphincterismus. Some of my pediatric friends tell me that constipation due to a tight sphincter and relieved by stretching the sphincter is a frequent finding in children and even in young babies. I have gained the impression that a tight sphincter in childhood is a common cause for dilated colons.

I always warn a patient that constipation is due to many causes and that in his case there may be other co-existing causes, but that so long as the tight sphincter persists he is bound to have constipation irrespective of the correction of any other causes. I advise vigorous manual dilatation in these cases and it is astonishing how commonly every vestige of constipation disappears.

Rectal cases should not be given an enema the day of operation nor a laxative the night before. If any cathartics are given they should be administered the second night before operation. I prefer gradual dilatation requiring five to fifteen minutes under gas-oxygen anesthesia rather than an abrupt divulsion the sphincter. The amount of force required to dilate a sphincter varies considerably as between a feeble old woman and a vigorous young athlete. It is difficult to describe to you the amount of dilatation to be employed. Except in those of feeble musculature the tendency is to dilate too little rather than too much. Any evidence of the muscle to contract on the fingers calls for more dilatation. A muscle which tends to "wink" at you after removing your fingers from the rectum is inadequately dilated. With complete dilatation you should be able to pass four fingers up to the vicinity of the metacarpophalangeal joints into the anus without meeting muscular resistance. It is very rarely that a properly dilated muscle ever requires a second dilatation. It is probable that stretching ruptures a large number of terminal nerve fibers and thereby lessens the likelihood of recurrence of the sphincterismus.

The milder grades of a tight sphincter may be treated by having the patient himself employ a Kelly conical metal rectal dilator for three to five minutes once or twice daily. The worst possible method of treating these patients is to administer cathartics by mouth to overcome the effects of a tight sphincter distant some 20 or 30 feet. Nourishment is rushed through the intestinal canal too rapidly to be properly digested and absorbed. One noteworthy case of this type was a woman thirty-five years of age who was referred to me by a very good internist for operation for incomplete intestinal obstruction. The patient had been operated upon for extra-uterine pregnancy ten years previously and it was assumed that pelvic adhesions had narrowed the intestinal lumen. She had been constipated for fifteen years and in recent years had been taking powerful cathartics. For the preceding five years she never had a movement even then except when she used an enema and she was in the habit of using several enemas daily to relieve the sensation of abdominal distention. She complained of constant borborygmi and griping intestinal pains. Within the previous six months she had frequent vomiting, had begun to lose weight and was a nervous wreck. On examination, I found the tightest sphincter I ever encountered. I had to use considerable force to introduce my little finger through her sphincter. There was no evidence of any scar tissue and the constriction was due entirely to the contractured muscle. I informed her physician of my findings and expressed the opinion that the underlying cause of all her symptoms was the tight sphincter and that her hyperperistalsis was due to excessive cathartics. He doubted this point of view and we therefore sent the patient for a gastro-intestinal roentgenologic study which proved to be negative for any evidence of obstruction.

After a most vigorous dilatation the patient was given mineral oil for one month and was permitted only one enema during the first week although she clamored for more of them during the first ten days. She soon acquired a daily stool habit, lost all her obstructive symptoms, regained weight, lost her nervous irritability, and had not taken a cathartic during the succeeding two years.

Another striking case was a man of fifty-four years of age who had had lifelong constipation. He had taken palliative treatment for hemorrhoids for twenty years. On the death of his proctologist he came to me for bleeding hemorrhoids. For the previous three years he had taken seven compound cathartic pills every night. He had a very tight sphincter. I forced him into operation which consisted of forcible dilatation of the sphincter and excision of hemorrhoids. He was given mineral oil for two weeks and when last seen five years later he had not taken any cathartic. I ascribe the cure of his constipation to the sphincter dilatation rather than to the hemorrhoidectomy.

A CASE OF GYNANDROUS PSEUDOHERMAPHRODITISM

THIS colored child is five years of age. She has never had an illness of any kind.

A few hours after the child was born the mother noted an abnormality of the external genitals. A small fleshy tab present at that time steadily grew larger until it now resembles a penis (Fig. 543). Thus far the child has been reared as a girl, but the

Fig. 543.—Hypertrophied clitoris simulating a penis.

penis-like ornament has begun to excite comment by girl playmates. The parents consulted Dr. Felix M. Katar and requested him to have the question of sex definitely determined. He sent the patient into the Graduate Hospital on the services of Dr. John A. Kolmer. The latter requested me to take charge of the child.

I found the pendulous penile structure has a slight groove extending from the glans to a perineal orifice from which urine

is expelled. The adjacent conformation does not suggest either labia or scrotum.

My own experience with pseudohermaphrodites is rather limited, but I believe the case to be a male child with perineal hypospadias and bilateral cryptorchidism. A gynecologist of vast experience in pseudohermaphroditism and a urologist were requested to examine the child and they both fully concurred in my opinion.

I thereupon advised the parents there was no reasonable doubt as to the child being a boy and that henceforth he should abandon the long hair and dresses of girlhood.

The parents were not satisfied and demanded that measures be taken to eliminate every doubt as to the question of sex. They were told this could only be done by means of an exploratory laporotomy and they insisted that this step should be taken. They had learned about true hermaphrodites and further requested that if both testis and ovary were found that the former should be excised so that the child could continue life as a girl.

The patient is now under nitrous-oxide-oxygen anesthesia preparatory to our carrying out the parents' requests. You will note there are no sex characteristics in the general appearance of the child except for its braids of long hair. Authentic cases of true hermaphroditism are exceedingly rare and I do not anticipate finding this patient is one.

The suprapubic median incision discloses a bladder containing enough urine to interfere with easy exploration of the deep pelvis and I will therefore ask an interne to use a small rubber catheter to evacuate the bladder. In the meantime I am able to palpate a uterus, tubes, and ovaries—all of a size unduly small even for a five-year-old child. Making further careful search I cannot find any trace of testes or vasa deferentia. We are therefore compelled to revise our diagnosis and now beyond all doubt declare this child to be a girl. In other words, she is a pseudohermaphrodite of the gynandrous type.

The interne now calls our attention to the difficulty he has had in trying to catheterize the patient. The number 15 F. soft rubber catheter which he attempted to pass, entered the

perineal orifice for a short distance and has doubled back on itself and the catheter tip is protruding. This behavior of the catheter indicates it has entered a vagina and not a hypospadias because the urethral orifice of a hypospadias is always contracted and in a five-year-old child would probably not permit passage of a 15 F. catheter and certainly would not permit the catheter to double back on itself as we see in this instance. A similar effort to pass a catheter before operation would no doubt have led us to the correct assumption that this child is a girl.

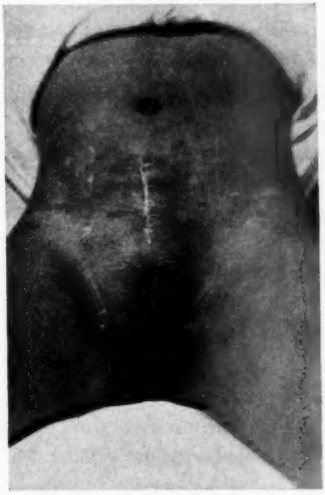

Fig. 544.—Postoperative appearance

I will now do an appendectomy to save the patient from possible future trouble before closing the abdominal incision. To prevent future embarrassment I will also amputate the overdeveloped clitoris just beneath the skin level and close the skin over it (Fig. 544).

A CASE OF INTERCOSTAL NEURALGIA SIMULATING AN ACUTE INTRA-ABDOMINAL CATASTROPHE

IRRITATION of the seven lower pairs of the intercostal nerves causes pain and tenderness of the anterior abdominal wall. Only a small percentage of physicians seem to realize that abdominal pain and tenderness are located in the abdominal wall itself more frequently than in the viscera. They commonly ignore the abdominal wall and place the blame upon whatever viscus underlies the area of maximum parietal pain and tenderness.

In earlier papers I have described in detail a few simple tests to demonstrate the parietal location of abdominal tenderness. The usual method of palpation only when the maximum relaxation of the abdominal muscles has been obtained is apt to prove most misleading as to the location of tenderness. Parietal tenderness is best demonstrated by palpation while the patient holds the abdominal muscles as tense as possible. The tensed muscles prevent the palpating fingers from coming into contact with the viscera and any tenderness thus revealed is necessarily parietal in location. Parietal tenderness is usually due to intercostal neuralgia and usually affects all the layers of the abdominal wall. In the presence of parietal neuralgia pinching of a liberal fold of abdominal skin and fat causes undue distress. Exceptionally skin and fat hyperesthesia may be absent when the palpation test over tensed muscles reveals tenderness in the muscles. Hence the palpation test is more reliable than the pinch test.

Depending upon the nerve or nerves involved, abdominal intercostal neuralgia may simulate any intra-abdominal affection which has pain and tenderness among its outstanding symptoms. In earlier papers[1, 2, 3] I have described how neuralgia very commonly simulates acute or chronic appendicitis and acute or chronic gallbladder disease as well as gastric, colonic, and renal lesions.

As a rule irritative lesions affect only the sensory fibers of the lower intercostal nerves, but in very exceptional instances the motor fibers are also affected and then muscular rigidity will be encountered along with the abdominal pain and tenderness. I[4] recently reported 5 cases of extensive abdominal pain, tenderness, and rigidity in the absence of an intra-abdominal lesion, and I will now discuss a similar case with you.

This patient is a Hebrew salesman twenty-nine years of age. Until recently he has never had any illness. Several weeks ago he developed vague pains in several joints. His tonsils were found to be infected and were removed under local anesthesia twelve days ago. Later that day he had postoperative hemorrhage and he was under ether that evening for two hours before the bleeding was finally checked by suturing the tonsil beds. Two days later, he had so fully recovered that at noon he was given permission to return to New York City the following day.

At five o'clock that evening (ten days ago) he suddenly developed a severe pain which remained localized in the right lumbar region about one hour and then extended over the entire abdomen, being most profound in the upper right quadrant. He vomited several times. The family physician, the laryngologist, and an orthopedic surgeon, who was a relative, were summoned. About midnight they asked me to see the patient.

The pain continued over whole abdomen, being most severe in upper right. The entire abdomen was "boardlike" with extreme rigidity in upper right quadrant. Tenderness present over whole abdomen, being more marked on right than left and most marked below the right costal margin. Thus far the history and examination indicated an acute perforation of a gastric or duodenal ulcer, but further examination cast doubt on this diagnosis.

The orthopedic surgeon, Dr. M. B. Cooperman, is familiar with intercostal neuralgia of the abdominal wall and before my arrival had found the tests for it positive. I repeated the tests and found that when the patient added voluntary tensing of the abdominal muscles his tenderness persisted over the whole ab-

domen. Pinching the skin and fat over the abdomen, chest, and buttocks gave evidence of marked hyperesthesia. These findings—most marked in the right upper abdominal quadrant—indicated the presence of widespread parietal intercostal neuralgia.

The abdominal pain and tenderness are entirely subparietal in perforation in cases in which parietal neuralgia is absent and the latter is absent in the great majority of perforation cases. A very noteworthy sign in perforation in the absence of neuralgia consists in finding that the palpation tenderness elicited over the boardlike rigid muscles entirely disappears while the patient adds voluntary tension to his involuntary rigid muscles. There was no doubt as to parietal neuralgia being present in sufficiently acute form to account for this patient's pain and tenderness, but we had to consider the possibility of a coincident ulcer perforation.

There was no history suggestive of previous ulcer, but ulcer perforation is not uncommon in the absence of preceding indigestion symptoms. Repeated vomiting is generally regarded as a sign pointing to an intra-abdominal lesion, but I have encountered vomiting so frequently in parietal neuralgia that I no longer regard vomiting as of any differential significance. The patient would complain bitterly of pain in paroxysmal attacks and on two occasions he was asleep five minutes later. The intermittent let-up in pain was far more suggestive of neuralgia than of peritonitis.

Many writers claim that acute ulcer perforation always causes immediate acceleration of the pulse, but my experience coincides with others that the pulse rate and temperature are usually normal during the first few hours after perforation; hence this patient's pulse rate of 50 and normal temperature could not be used as an argument either for or against perforation. There was no diminution in the area of hepatic dulness such as commonly, but not invariably, occurs from escape of air into the general peritoneal cavity following perforation. Almost invariably patients with perforation hold the position in which they lie, but this patient rolled from supine position on to his

side three times during the course of my abdominal examination—a most unlikely occurrence in the presence of perforation.

The adipose tissue on this patient was very thin and the irregularities of contracted muscles were readily visible over the abdomen. In addition, firmly contracted serratus magnus digitations on both sides of the chest were visible and palpable. I have never observed contractures of the serratus magnus due to an intra-abdominal lesion and their presence suggested that they as well as the rigidity of the abdominal muscles were due to an extra-abdominal nerve irritation.

Intense abdominal rigidity is seldom encountered in intercostal neuralgia except when the latter is due to basilar pneumonia or pleurisy. Physical examination of the chest was negative, but we decided to send the patient into the Graduate Hospital for roentgenographic examination of the chest to determine the possibility of a pulmonary embolus from the site of the tonsil operations. This immediate examination proved negative as did a physical examination of the entire chest made by Dr. G. M. Piersol. The total leukocyte count was 18,600 and 90 per cent of them were polymorphoneuclears. This count was compatible with either perforation or infected tonsil beds. Urinalysis was entirely negative.

After weighing all the evidence I expressed serious doubt as to any part of the symptoms being caused by an intra-abdominal lesion of any kind. However, a visceral lesion of some variety, particularly ulcer perforation, could not be absolutely excluded and I fully concurred in the consultation opinion that an immediate exploratory laparotomy should be performed. I did specify, however, that the exploration should be very limited provided a purulent exudate was not encountered immediately on opening the abdomen. The only intraperitoneal lesion that gives such widespread intense rigidity is diffuse peritonitis. The patient and his family were frankly notified that the exploration might be negative, but we feared delay might spell disaster if he did have an intraperitoneal lesion.

At three in the morning a 1½-inch right upper rectus incision

was made under gas-oxygen anesthesia. Nicking of peritoneum failed to disclose any exudate and it was then apparent no general peritonitis was present. The peritoneum was opened the full distance of the short muscle incision. Palpation of gallbladder, right kidney, and pancreas was negative. The gastroduodenal juncture was easily delivered and was found free from disease. The hepatic flexure tended to prolapse and it was brought out of the wound in the futile hope of delivering the appendix. The latter was not visualized, but palpation in its vicinity was negative. The incision was closed without drainage. The entire exploration required only a few minutes.

The preoperative recognition of the parietal neuralgia saved this man from having a more extended incision and widespread exploration for some nonexistent intra-abdominal lesion which might account for his symptoms. Widespread exploration in acute parietal neuralgia is usually followed by a hectic postoperative course of vomiting, "gas pains" and abdominal tenderness. He did not experience these difficulties.

His pain was kept under control by an occasional hypodermic of morphine and two days after operation his rigidity began to subside, continuing most marked in the upper right quadrant. In another three days all pain and rigidity ceased. His sutures have been removed and the wound is fully healed. He had fever only the day of operation and that did not go above 99.6 F. He has had a persistently slow pulse, the rate today being 54. He has been out of bed the past three days and will leave for home today.

As we examine this patient, we note he has the sway back, round shoulders, and pot belly so characteristic of the viscerooptotic habitus and so frequently the underlying cause of chronic intercostal neuralgia of the anterior abdominal wall. With the bad posture predisposing to neuralgia, his acute attack was precipitated by the toxemia from his tonsil operations. As the operative field returned to normal his toxemia let up and all of his symptoms subsided. We have advised him to wait six or eight weeks for his incision to become firm and then take up the Goldthwait exercises of abdominal and buttock muscles to cor-

rect his posture and thereby prevent a recurrence of acute abdominal symptoms if and when he develops another focus of acute infection.

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CLINIC OF DRS. ELDRIDGE L. ELIASON AND
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PATHOLOGIC FRACTURES

Introduction.—Little is said in text-books about pathologic fracture, the condition being generally discussed in a rather cursory manner. Erroneously, it is often spoken of as being spontaneous in origin, which infers its occurring suddenly and without apparent cause. Each so-called "spontaneous fracture," however, has a definite pathologic basis. Each pathologic fracture, depending upon its etiology, varies as to its treatment and prognosis. Essentially, pathologic fractures caused by benign or chronic conditions have a favorable prognosis, while those due to malignancy and acute suppuration have an unfavorable one.

Definition.—A pathologic fracture is one occurring from an otherwise insignificant force acting upon a bone already weakened by disease, one that is fragile.

TABLE 1 (PERSONAL SERIES)

Bone disease.	Cases.	Per cent.	Group.	Group, per cent	
Carcinoma	18	25.7			
Sarcoma	9	12.9			
Cysts	6	8.6	38	54.3	Tumors
Myeloma	5	7.2			
Osteomyelitis	10	14.3			
Lues	1	1.4	12	17.1	Infections
Paget's disease	1	1.4			
Osteogenesis imperfecta	6	8.6			
Rickets	3	4.3	10	14.3	Nutritions
Osteomalacia	1	1.4			
Atrophy	6	8.6	6	8.6	
Unknown	4	5.7	4	5.4	
Total	70	100.0	70	100.0	

Etiology.—Fracture statistics on the whole are deficient in complete analytical figures as to the relative causes of pathologic fracture. The literature fails to give a true relation of etiologic proportion. Many cases originating as osteomyelitis, malignancy, etc., are frequently lost track of (in *x*-ray files for example) because of the major interest of the etiologic disease. Statistics relative to the incidence of disease in causing pathologic fractures vary, too, with the size and type of hospitals. Speed states, for example, that at the Cook County Hospital he sees a large number of pathologic fractures due to syphilis each year. His is a much higher figure than are those in smaller hospitals. Until a much larger number of these cases are available for study the knowledge of pathologic fractures will be largely individualistic. Our own small series is appended in Table 1. From this series it will be noted that bone tumors, benign and malignant, occupy the most important rôle in the production of pathologic fractures. At the same time it is unfortunate that the entire subject of bone tumors is one which is so controversial. The microscopic diagnosis of a questionable bone lesion, even in the hands of the best pathologists, is often a difficult one to make. Considerable strides, however, are being made by the Bone Registry Committee and others, and it is hoped that the near future will greatly clarify the problem.

Kellogg Speed finds malignant disease to be the most common cause of pathologic fracture in his experience. This is indirectly confirmed by Christiansen, who, analyzing 1000 cases of bone tumors (disregarding fractures for the moment), found 918, or 91.8 per cent, were malignant (Waring). From our personal series, attached, and from the observation of others, it is probably quite safe to say that bone tumors (malignant and benign) come first as the cause of pathologic fracture, inflammatory changes second, nutritional disturbances third, and neurotrophic changes fourth (see Table 1).

Incidence of Bone Involvement.—The incidence of pathologic fracture is found to be greatest in the long bones connected with the trunk. The femur apparently suffers most. The humerus, fibia, and radius are the next most often frac-

tured. The statistics of others approximate the personal ones given below.

As far as we can ascertain there are several factors causing this frequency.

The femurs bear the most body weight. The extensor-flexor muscles, connecting the femur to the body, are powerful. Consequently, when the femur is diseased, weight bearing and muscular traction tend to produce fracture, in the absence of sufficient trauma.

The neck of the femur is the weakest link in the chain of the bones comprising the lower extremity. This is accentuated in elderly individuals who are most liable to malignant disease. Again, it is liable to atrophic changes in the aged and bedridden patients.

In the upper extremity the majority of mechanical forces center at the shoulder joint. This includes the upper third of the humerus.

There is also an anatomico-pathologic combination that makes for fracture-site incidence. Bone disease, which leads to pathologic fracture, is found more often in the long bones than in the flat. The cancellous portions are frequently affected. Certain bone lesions tend to appear in the epiphyseal portions, rather than in the shaft, and consequently muscle action, greatest near a joint, accentuates any force upon the potentially weak part.

In an incomplete, personal series, we find the bones most affected by pathologic fracture to be as follows:

TABLE 2

Bone involved.	Cases.	Per cent.
Femur	35	50
Humerus	13	18
Tibia	6	8.6
Multiple	5	7.2
Radius	4	5.7
Ribs	4	5.7
Clavicle	1	1.4
Ulna	1	1.4
Acetabulum	1	1.4
Total	70	100.0

Bone metastasis from organic malignant disease may occur in flat or long bones. Flat bones are seldom subjected to trauma, except by direct force. Long bones are subject to direct and indirect forces. The latter includes torsion and weight bearing as well as muscle play. As an illustration of this, one seldom sees a pathologic fracture of the skull or ilium.

Fractures of the phalanges of the hand and foot are not included in Table 2. In 10,400 fractures at the University Hospital up to 1926, the pathologic incidence was 0.35 per cent. MacDonald found the incidence of pathologic fractures at the Massachusetts General Hospital to be .018 per cent. This rerepsented 24 pathologic cases in 1405 cases of fracture between the years 1910 and 1920.

Age and Sex.—Grossly, pathologic fracture occurs most often in the extremes of life and is determined largely by the disease which predisposes to the fracture. Nutritional defects as rickets and scurvy, for example, occur in youth. Sarcoma occurs in youth and early adult life more often than in the aged, while carcinoma, neurotrophic or atrophic changes occur oftenest

TABLE 3

(*a*) *Fragility due to local lesion:*
1. Tumors:
   Benign—cysts (cystic fibrosa), enchondroma, thyroid.
   Malignant—carcinoma, sarcoma, hypernephroma, endothelioma, multiple myeloma.
2. Infections:
   Acute—Calvé-Perthes, Köhler's, Kümmell's, Keinboch's and Osgood-Schlatter disease.
   Chronic—tuberculosis, syphilis, Paget's.
3. Chemical and pressure causes.

(*b*) *Fragility due to general disease:*
1. Neuropathic.
2. Senility.
3. Osteoporosis of disuse.
4. Osteomalacia, rickets, scurvy, etc.
5. Metabolic disturbances, diabetes, hyperparathyroidism.

(*c*) *Fragility due to hereditary disease:*
1. Osteogenesis imperfecta.
2. Osteosclerosis (marble bones).
3. Gaucher's splenomegaly.

in late, middle, and advanced life. Infectious conditions occur in the first age period—one to twenty, whereas the chronic infections do not discriminate. These factors are more intimately referred to under their respective headings later. It may be well to note at this time that the prognosis, as a rule, is better in the younger patients than in the older ones. One might even say that the younger the patient and the earlier the disease (with but a few exceptions), the better the prognosis, and the older the patient or the longer the period of the disease, the more dubious is the final hoped-for result.

Classification.—For reference purposes we have classified the fragility of bones under three major headings. In the main, fragility is generally due to a local lesion, a systemic affection, or a hereditary diathesis.

FRAGILITY DUE TO LOCAL LESIONS

Bone Cysts.—The first under consideration is local cystic disease of bone. Under this heading are included osteitis fibrosa cystica (giant cell tumors, bone cysts, etc.). Blood or dentigerous cysts of the jaw, hydatid and actinomycosis cysts and endochondromata of the phalanges and metacarpals are likewise included by some (French, Waring). Primary cysts will be considered first. Blood cysts are found in degenerating sarcoma (French). Hydatid cysts are uncommon in America, but may be present in individuals who have lived in countries where the disease is prevalent (Russia, Armenia, and the East). Such cysts affect the diaphyses of the long bones as a rule, and convert the shaft into a thin walled tube which undergoes fracture as a result of slight trauma or muscular action. The existence of such cysts would hardly be suspected unless there were known hydatid disease elsewhere, especially in the liver. Cysts of the jaw or dentigerous cysts may be the site of fracture. Landois has pointed out that cysts due to echinococcus, cysticerci, actinomycosis or chronic osteomyelitis of bacterial origin may result in fracture. While fracture through cysts often cures cysts (osteitis fibrosa cystica) fractures resulting from other types of cysts usually require open reduction and curettage. Treatment

other than immobilization will depend on the treatment of the causative factor.

Chondroma or Enchondroma.—A chondroma is a tumor composed of cartilage. Chrondomata of bone are benign though those connected with soft tissues may develop into chondrosarcoma. They usually form at an epiphyseal line and extend distally—expanding widely as they grow (French). The phalanges are the commonest site, but the lower end of the femur, the great trochanter, and upper end of the humerus may also be

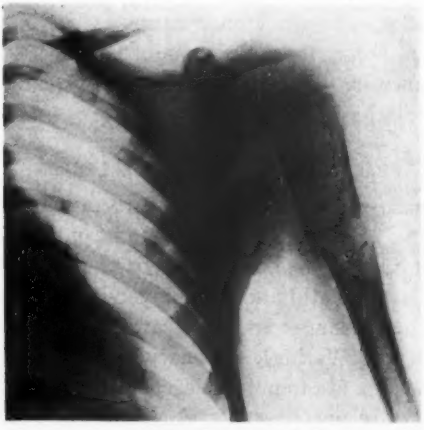


Fig. 545.—Bone cyst or cystica fibrosa with fracture. Boy, eight years old. Insignificant fall. *x*-Ray shows typical lesion of a large bone cyst involving upper third of humerus, through which there has occurred a pathologic fracture. The cyst has produced some thinning of the cortex, but shows little tendency to expansion of the bone. The apparent trabeculations are evidently fractured portions of the thin bone shell.

affected. Though usually found in the long bones, Babcock states they may locate about the hip joint, the neck of the scapula, and about the glenoid fossa. They are slow in growth, frequently multiple, and may be peripheral or central. The deformity of the tumor is quite marked and pain from nerve pressure may occur with ulceration of the overlying skin. Unless excised, the bone is gradually destroyed and a pathologic fracture results. If recurrence takes place and sarcomatous changes appear early,

amputation followed by radiotherapy is essential. There is no predilection as to sex or age except that the lesion does not usually occur after middle life. When the condition is brought to the attention of a surgeon only after a pathologic fracture has occurred, it is necessary in the larger long bones to excise the enchondroma prior to immobilization before union will take place. Shortening may result in small bones, as the phalanges. When

Fig. 546.—Bone cyst with fracture and union. Same as Fig. 545 two and a half years after fracture. *x*-Ray shows the bone practically restored to normal. There is slight deformity and some increased thickening of the cortex with sclerosis at the site of the fracture. It is interesting to note that the healed fracture site is much further down the shaft than was the cyst two and a half years previously. The photographer has reversed this print.

the shortening is sufficient to cause marked deformity or a disturbed functional and economical result, amputation may be required.

Osteitis Fibrosa Cystica.—By far the greatest number of pathologic fractures due to cystic disease of bone is the result of osteitis fibrosa cystica. About this term and several others

connoting the same condition (osteitis fibrosa, fibrous cysts, bone cysts, cystic disease of bone, fibrocystic disease of bones, von Recklinghausen's disease, etc.) lies a certain amount of confusion. Geschickter and Copeland have recently clarified the situation somewhat. They have reviewed 400 cases of bone tumors of the giant-celled group, including giant-celled tumor,

A B

Fig. 547.—Metastatic carcinoma. Woman aged fifty-two, primary lesion in the breast with generalized bone and visceral metastasis. Note the "decayed wood" appearance of the lesion before the fracture occurred (A). B shows the fracture eight weeks after the insignificant trauma. Abundant callus is present and union is solid.

osteitis fibrosa, solitary bone cyst, and are of the opinion that the three are one and the same condition in different stages and all due to trauma. The present writers are in accord with these views.

The condition occurs most often in youth and at the metaphyseal regions of the long bones, chiefly the humerus, femur, tibia, and radius. A fracture from slight violence is frequently the first intimation of trouble. The *x*-ray findings are characteristic (Fig. 545). The fracture is not very painful and union occurs, usually with a resultant cure of the cystic condition. Follow-up reports have shown, however, that at least in the cases without fracture operation, curetting, and destruction of the cyst and its contents followed by irradiation have given the most lasting cures.

Metastatic Carcinoma (Fig. 547).—Carcinoma of the bone is always metastatic, or the result of invasion from an overlying tumor, as an ulcerating epithelioma of the jaw. It is well known that carcinoma, especially of the breast, etc., tends to bone metastases. Carcinoma of the stomach may also give rise to secondary deposits in the bones. Waring, for example, found metastasis to bones occurred in 53 cases (4.6 per cent) of 1144 autopsies upon cancerous patients. Of the 53 cases, 34 or 64 per cent were carcinoma of the breast primarily. The first signs of malignant disease may be osteoporosis, erosion, and fracture. Usually more than one bone is involved. Unlike sarcoma, the bone lesion is rarely large enough to command attention and the growth is slow. A moth-eaten appearance or "decayed wood" construction with a compensatory periostitis results. The common sites for metastasis, with fracture, are the femur, humerus, ribs, and sternum. Handley (Speed) in 329 cases of carcinoma of bone, due to metastasis from carcinoma of the breast, found the bone incidence as follows:

	Per cent.
Sternum	9.0
Ribs	8.0
Femur	4.2
Spine	3.6
Humerus	2.7
Cranial bones	2.7

Handley states that in carcinoma union is the rule. Pancoast estimates that union occurs in probably 40 per cent of these cases with or without radiation.

The prognosis is, of course, very poor, as with other malignant bone affections. The local lesion causing the fracture is only an incidental part of the generalized malignancy. The prognosis is similar to that in sarcoma of which Ewing remarks: "The surgical treatment of bone tumors is highly unsatisfactory." Amputation is seldom indicated from a curative point of view as it may be indicated in early cases of sarcoma. It may be performed for the patient's benefit to shorten his hospitalization and to free him from malodorous dressings.

Sarcoma (Fig. 548).—Sarcoma of bone is usually primary and of the osteogenic type. Pathologic fractures occur and union

Fig. 548.—Pathologic fracture of the clavicle due to sarcoma.

after fractures is possible, but rare (Babcock). Waring has seen union occur, but Bloodgood has seen only one case in which union occurred and one other questionable case. Meyerding (see Waring), analyzing 109 cases of sarcoma involving bone, found the different types to be as follows:

	Cases
Mixed-celled sarcoma	51
Osteosarcoma	19
Chondrosarcoma	17
Round cell	14
Fibrosarcoma	8
	109

Waring classified sarcoma of bones into periosteal sarcoma and endosteal or central sarcoma. The first should not be confused with parosteal sarcoma which is sometimes termed "periosseous fibrosarcoma." This latter is not a true bone tumor, but lies adjacent to bone and may by pressure affect bone without invading it.

Periosteal sarcoma is more common than endosteal. The metaphyses of long bones is the commonest site. Seventy-two per cent (Babcock) involve the lower extremity and 82 per cent of these occur near the knee. The shoulder girdle is next in frequency. The humerus is usually attacked above the deltoid tubercle, the scapula in its glenoid cavity or spine, and the clavicle in its outer one half. Other bones may be involved, but are seldom fractured. The fact that the lower epiphyseal end of the femur and upper epiphysis of the tibia are the last to ossify may explain the predilection for this area (Babcock).

Trauma is said to precede 50 per cent of cases of osteogenic sarcoma and to develop within one month after injury in 30 per cent of cases. The bones concerned in the formation of the knee joint and shoulder girdle likewise receive a large share of trauma in the young, among whom it most often appears. Strangely enough the lower end of the radius (though often injured) is rarely affected and there is no record of the distal end of the ulna ever being involved.

Males are effected in the proportion of 3 to 1, though females predominate during the first decade of life. Sarcoma of bone occurs chiefly in childhood before the age of twenty, and is rather rare after the age of forty, except where it is secondary to Paget's disease. According to Codman (Babcock) 14 per cent of all patients with Paget's disease die of osteogenic sarcoma.

The *x*-ray picture of the lesion is generally characteristic. There is a fusiform swelling or spindle contour at the end of the bone. The joint or epiphysis is not invaded. The periosteum becomes markedly elevated with a thickened "lipping" of its margin. In 18 per cent there may be noted fanlike radiations which give it the so-called "sun-rays" appearance. Expansion of the shaft rarely takes place. The spindle mass is caused by pene-

tration of the bone by the tumor and the formation of a mass around the shaft.

Treatment is more hopeless when a pathologic fracture occurs, than otherwise. By the time the surgeon sees the case the resulting trauma to the tissues has opened the blood and lymphatic vessels, thus predisposing to metastasis. The patient then dies from sarcomatosis. The mixed toxins of Coley, irradiation, and amputation have cured some cases of sarcoma, but rarely so when fracture occurs. Cases thought to be cured of their local lesion by irradiation generally die later from metastasis. By the time the bone is involved sufficiently to result in fracture, dissemination has either begun or occurs with the injury to the tissue at the time of fracture. Cordotomy and rhizotomy have been advised by some for the control of pain.

The senior author has successfully treated 2 cases by amputation. One was in the distal portion of the femur and one in the tibia. Both diagnoses were proved by the microscope. One case is alive at the end of eighteen years and the other at the termination of twelve years. There is no doubt that amputation is of value only when the condition has just begun and when it is distally located. A high amputation is then successful. Coley has recently reported 2 cases of the endothelioma type with apparently successful cures by operation and the use of Coley's fluid. One patient was well three years later and the second four and a half years after. Figure 550 illustrates a recent case of our own which was treated by excision and intramedullary graft.

Statistics show (Ewing) that nearly all osteogenic sarcomas prove fatal, and while recovery seems to have occurred in rare cases "this fortunate outcome is the meager fruit of large numbers of useless amputations." It is our feeling that amputation in many instances has its advantages. It shortens the hospitalization of the patient. It relieves the patient of an incapacitating, often painful, frequently ulcerating, foul smelling lesion requiring painful dressings. Furthermore, after such operations patients have been known to live with comparative

comfort for many months despite the presence of visceral metastasis (lungs) at the time of operation.

Hypernephroma (Metastatic) (Fig. 549).—Hypernephroma (Grawitz tumor, suprarenal rest in kidney) is now considered to be a malignant adenoma or adenolipoma of the kidney. It occurs generally in young girls and in adult men. The condition is extremely malignant and metastasis occurs via the blood stream to the liver, lungs, and bones. The bones most often affected are the skull, humerus, and femur. Cases have been re-

Fig. 549.—Pathologic fracture of neck of femur due to hypernephroma. Note shortening and attempt at union. Female, forty-two years old. Died seven months later. *x*-Ray shows a large rarefied area in the upper end of the femur due to a metastasis from a hypernephroma. There has been shortening of the neck and some new bone formation as the result of a pathologic fracture through this area.

cently reported by Mazzini, MacKechnie, and by Broster. Rapid recurrence generally follows extirpation of the original tumor. Excision or amputation when pathologic fracture occurs offers no hope of cure. Death usually occurs in from two months to two years. Radiotherapy and Coley's fluid may be tried. The prognosis is more grave than that of a pathologic fracture due to sarcoma.

Thyroid (Metastatic).—Bloodgood states that the majority of these lesions are metastases from a malignant adenoma of the thyroid gland, although other authorities consider the condition nonmalignant. Blumer has analyzed the reported cases and finds that 38 per cent occur in the bones of the face and cranium, 16 per cent in the vertebrae and only 15 per cent in the long bones —hence fracture is comparatively rare.

Endothelioma (Fig. 550).—An endothelioma is a tumor originating from endothelium, and resembling both sarcoma and carcinoma. It forms about 7 per cent (Babcock) of the sarcomas of bone.

It affects the long bones more often than the flat. The most common sites are the tibia, fibula, humerus, ulna, and the femur. Other small bones of the feet, ribs, vertebrae, etc., may be affected. In the latter locations it must be differentiated from multiple myelomata. The tumor widely involves the shaft of the long bones or starts in multiple areas. The tissue itself is soft, mushy, and whitish gray. While it destroys bone a regenerative process likewise takes place at the periosteal borders. Various layers are formed in the course of time giving the roentgenogram the peculiar appearance termed "onion layer" (Babcock).

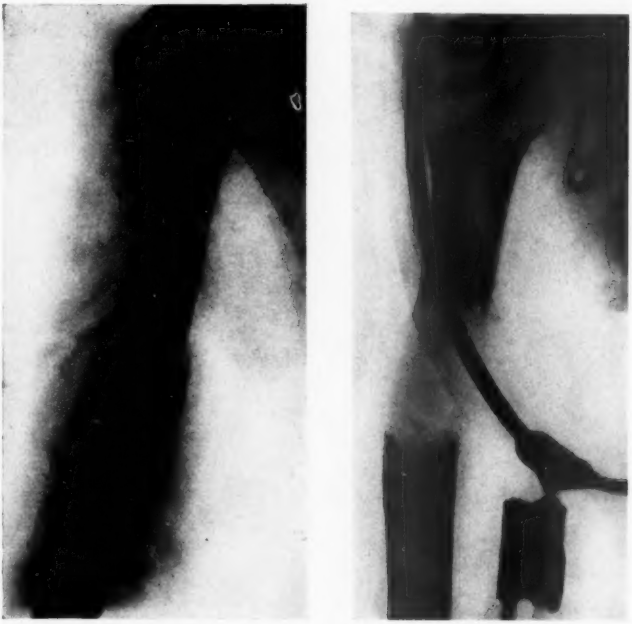
The disease frequently follows trauma and is usually one of youth, 50 per cent of the cases occurring before the age of fifteen. Because of the pain, limitation of motion, slight fever, and leukocytosis, it may be mistaken for osteomyelitis. The joint is seldom involved and pathologic fracture occurs late.

Metastasis via the blood or lymphatic occurs with great rapidity in the lungs, skull, various bones, liver, spleen, and regional lymph nodes.

The prognosis is very poor as death generally occurs in from six months to two years. The disease is very sensitive to irradiation.

Treatment consists of immobilization and possibly irradiation. Union may occur as temporary improvement or retrogression takes place with radiotherapy. If the condition occurs

in an extremity and is recognized before metastasis takes place, amputation in our opinion should be employed.



A B

Fig. 550.—Male, aged thirty-two, with a history of neuralgic pains in his arm and shoulder for eighteen months previous. On 1/24/30, while steering a small car, he suddenly experienced a sharp pain and helplessness in his right arm. His physician diagnosed a fracture and *x*-ray revealed the above described as a fracture through a bone cyst, myeloma or giant-celled tumor. The *x*-ray (B) taken three months later shows extensive absorption of bone with no regeneration and no union of the fracture. The diagnosis now was sarcoma or Ewing's tumor, or giant-celled tumor. A cortical lesion diagnosed as bone cyst was discovered in the shaft of the ulna of the same limb, other bones of the skeleton were negative for tumor evidence. The lesion of the humerus was excised and a fibula transplant resulted in an excellent union now, four months later. The microscopical diagnosis was angio-endothelioma.

Multiple Myeloma (Figs. 551, 552).—Myelomata, in comparison with the single benign myeloma of bone, are multiple, malignant, and subject to metastases. Fortunately the condition is rare

(Waring). The bones most commonly affected are the ribs, sternum, vertebrae, cranium, ilium, and (very rarely) the long bones of the upper extremity. Often the first symptom is pain in one of the areas most affected. As the disease progresses metastases take place in other bones. When the spinal column is affected the pressure on the cord may resemble that of a spinal cord tumor. Pathologic fracture is seldom seen as the flat bones are oftenest involved. Anemia is sometimes present. Males, generally be-

Fig. 551.—Pathologic fracture at the surgical neck of the humerus due to multiple myelomata. Female, forty-six years of age. Multiple fractures occurred in both femurs. *x*-Ray shows a fracture through a large area of rarefaction in the upper end of the humerus. A similar rarefied area is to be seen involving the medullary cavity in the midportion of the shaft. Note the thinning of the cortex by the myelomatous tumors predisposing the bone to pathologic fractures. This patient has a dozen or more lesions demonstrable in the skeleton by *x*-ray. Fractures were present also in both femora. (See Fig. 552.)

tween forty and sixty years of age, are most likely to be affected. The prognosis is very poor as death usually occurs in a few months. Surgery or radiation is of little value because of the

widespread metastases. Treatment is directed to immobilization, sedatives, and attending complications.

Infections.—The infectious diseases of bone leading to pathologic fracture are subdivided into the acute and chronic.

Fig. 552.—Pathologic fractures due to multiple myelomata. Same case as Fig. 551. Death occurred before union could take place. Further fractures occurred. *x*-Ray shows numerous ovoid areas of rarefaction within the medullary cavity of each femur. These areas are the result of bone destruction, characteristic of multiple myeloma. There is a fracture through the involved portion of the left femur and multiple fractures in the right with accompanying marked deformity.

Acute Pyogenic Infections (Figs. 553, 554).—Acute osteomyelitis may form a localized abscess involving a large portion of a bone and lead to fracture. As a rule, however, more extensive destruction takes place with a resultant periostitis, necrosis, sequestrum formation, and pathologic fracture. The first two decades of life (males particularly) are probably more often affected than any other. The condition is sometimes erroneously diagnosed rheumatism, subdeltoid bursitis, etc. This is understandable when *x*-rays taken at the beginning of

pain may be negative for bony pathology. The treatment is essentially that of an infected compound fracture, namely, adequate drainage plus immobilization. When such cases come to the surgeon early, the prognosis is good. In neglected cases, nonunion may occur, particularly when improper splinting has been applied. Union is the rule in pathologic fractures due to acute osteomyelitis where early drainage has been secured. Excessive callus is frequently seen.

Fig. 553.—Pathologic fracture due to chronic osteomyelitis of nine weeks' duration. Diagnosed rheumatism by the first physician. Abscess and fracture resulted. Condition spread to shaft and caused a second fracture. Amputation eventually performed. *x*-Ray shows a fracture of the surgical neck of the humerus through a rarefied area which extends for a considerable distance down the medullary cavity of the bone. A low-grade osteomyelitis showing but slight reaction to the infectious process.

Chronic Infections (Fig. 555).—*Syphilis.*—Syphilitic disease of bone *per se* is seldom a cause of pathologic fracture. Such fractures, though, occur fairly often in patients with cerebrospinal syphilis.

The local affection of bones is generally a periostitis which results in a thickened cortex and osteosclerosis. Nodular swell-

ings may occur as in "saber shin." Subperiosteal gummata may destroy bone and weaken it sufficiently to cause pathologic fracture. This is particularly true where an ulceration or infection is engrafted upon a secondary osteomyelitis. Constant has reported pathologic fractures of the femur due to syphilitic osteomyelitis. Silhol has reported a similar case with recurrence.

Fig. 554.—Acute osteomyelitis of femur and pathologic fracture. Boy, thirteen years old. Hurt thigh in football. Incision revealed an abscess; *x*-ray, a periostitis. Three weeks later present picture showed fracture. *x*-Ray shows an oblique fracture at the junction of the middle and upper thirds of the right femur. The periosteum is elevated and thickened and there is an irregularity and mottling of the bone in the region of the fracture indicative of an acute osteomyelitis.

Achard and Walter have made a study of clavicular fractures in syphilitics. Figure 555 shows a personal case.

Tuberculous Osteomyelitis.—These affections are often seen in the phalangeal, tarsal, and carpal bones of children as strumous

dactylitis. There is a localized fusiform swelling of a phalanx or metacarpal bone, caused by a tuberculous caseous process that breaks through the cortex. In adults, a diffuse thickening from periostitis and the formation of a central sequestrum occurs. With necrosis, a pathologic fracture may take place.

The disease attacks long bones in the region of the epiphyses. The short long bones are usually affected nearer the shaft center.

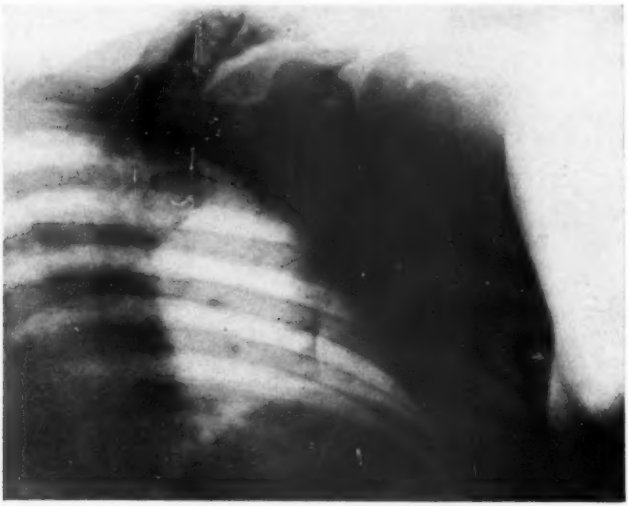


Fig. 555.—Syphilitic osteomyelitis of clavicle with pathologic fracture. Male, thirty-two years old. No injury. Fracture painless. Large spleen. Fifty neosalvarsan injections. Secured good union. *x*-Ray shows generalized mottling of the involved portion of clavicle with increase in width of the bone due to the accompanying periostitis with new bone formation.

The femur, tibia, humerus, and bones of the forearm are the ones most often fractured. The ribs may be invaded by extension. Leuormant has reported pathologic fractures of ribs in tuberculous osteitis.

In America the condition is on the wane, due no doubt to better milk laws. The junior author has had occasion to see innumerable cases of tuberculous osteomyelitis in Turkey, the

Balkans, and southern Russia where the majority of cows are affected with bovine tuberculosis. The condition occurred most often before the age of eighteen.

In addition to immobilization, local surgical interference is generally necessary, sequestrectomy, curettage, and drainage. The best results are secured by direct exposure of the bone to sunlight, the administration of high grade milk in large quantities, and codliver oil. In hot weather, ergosterol, viosterol, acterol, etc., are better tolerated than codliver oil. In the winter, the ultraviolet ray should be used locally and over the body surface. The latter seems to promote calcium absorption. Callus is generally abundant and the prognosis as to union is good. If proper attention is not paid to the underlying cause, chronic osteomyelitis results.

Fig. 556.—Paget's disease with pathologic fracture of femur. Female, seventy-three years old. While standing, leg "gave way"; very slight discomfort. *x*-Ray shows marked thickening of the cortex and irregular areas of bone density, characteristic of Paget's disease. *x*-Ray of the skull will usually confirm this diagnosis.

Paget's Disease (Figs. 556, 557).—Paget's disease is a condition of unknown origin, and very likely due to an infectious process. It is a chronic, progressive, and symmetrical disease affecting chiefly the long bones, skull, and spine. Early hyperemia, bone absorption, and softening take place. These changes are followed by bending, thickening, sclerosis, and a tendency to sarcomatous change.

Fig. 557.—United pathologic fracture due to Paget's disease. Same case as Fig. 556. Shows union ten weeks after Russell traction treatment. Note the dense callus formation. *x*-Ray shows a pathologic fracture in the right femur junction of the middle and lower thirds. The fragments are in good position. There is considerable bone callus present at the site of the fracture. The entire shaft shows diffuse and irregular areas of increased bone density. There is considerable thickening of the cortex throughout. The appearance is that of Paget's disease.

According to Babcock the marrow first becomes vascular and the bone, rarefied and partially decalcified, bends under pressure. Later excessive bone formation occurs with calcification and

sclerosis. It is during this latter stage that pathologic fracture is most apt to occur.

The immediate production of fracture is generally caused by two principal factors. First, in this stage of the disease the muscular structures tend to waste and are no longer capable of acting as shock absorbers. Second, the overcalcified bone is like an old automobile spring that has lost its flexibility. A moderate amount of direct force or torsion with the defensive muscles now weakened results in a fracture. This is similar to the fractures occurring in "marble bones" or osteosclerosis generalisata. The bones in this latter condition are also deficient or lacking in elasticity.

The curved legs, bowed knees, kyphotic spine, and anthropoid carriage attest the progress of this incurable disease. The femur and humerus are the bones most liable to fractures. The fracture line itself is characteristic, and generally is clear cut, transverse or of the "step type." Union occurs, but is slow and prolonged immobilization is required. Excessive callus is the rule.

The progress is favorable as far as eventual union is concerned, but it is grave inasmuch as 14 per cent (Codman) of the patients die of a secondary osteogenic sarcoma. "If there were nonunion of a fracture in a bone, evidently an example of Paget's disease, I should be suspicious of secondary sarcoma and amputate at once" (Bloodgood). The presence of osteogenic sarcoma in later life is almost presumptive evidence (Babcock) of Paget's disease. Recurrent fractures are apt to follow.

During the progress of the general disease the skull becomes extremely thick and the intracranial space decreases. As a result, severe headache, cerebral pressure symptoms, and mental deterioration take place. In the elderly, softening of the fractured ends may develop into sarcoma.

No cure for Paget's disease has been discovered. Parathyroid, thyroid, calcium therapy and irradiation have been tried, but are not specific. As the condition is often ushered in with a slight fever, dull aching pains, and hyperplasia of bones it is not without hope that some one may yet discover an infectious agent to be its cause and a subsequent cure result.

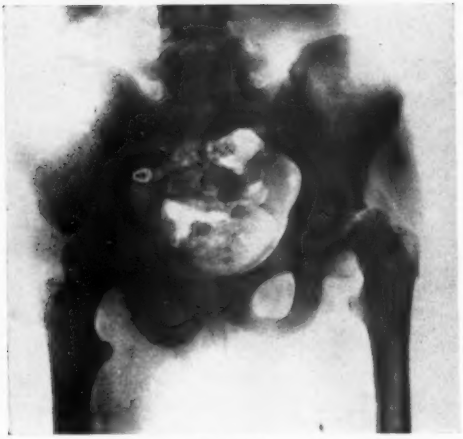


Fig. 558.

Fig. 559.

Figs. 558, 559.—Osteochondritis juvenalis femoris: girl, aged eleven. In June began limping. In August an *x*-ray was reported negative. No pain. In December, four months later, while walking on a level pavement, the limb gave way with resultant slight pain. *x*-Ray at this time revealed an epiphyseal separation, with diaphyseal bone vacuolization (Fig. 558). Diagnosis: Osteochondritis. *x*-Ray (Fig. 559) taken one year later shows perfect union as well as recovery from the inflammatory condition. Note: Examination of the first (August) *x*-ray reported negative revealed a "slipping epiphysis with vacuolization and absorption of the diaphyseal border."

Fragility Due to Infection of Epiphyseal Areas (Figs. 558, 559).—Recent scientific advancement has been instrumental in clearing up the etiology of obscure diseases of the past. Among this group are various affections of the epiphyseal areas of growing bone. While mild trauma enters into their production, systemic infection undoubtedly leads to a low grade inflammatory state that predisposes to dissolution. The following conditions fall into this category:

Osteochondritis deformans juvenilis coxae (Legg's or Calvé-Perthes disease).

Pathologic separation of the epiphysis of the head of the femur results in deformity and shortening unless detected and treated early. Immobilization in a Whitman cast and prevention of too early weight bearing afterward suffice for a cure. The prognosis is good.

Epiphysitis of the tarsal scaphoid or Köhler's disease. Elimination of foci of infection, attention to static requirements and immobilization bring favorable end results.

Kümmell's disease or traumatic spondylitis. Local trauma is often the exciting factor causing this condition, though *x*-rays at the time of injury fail to show any pathology. The patient recovers from this stage which is thought to be a hemorrhagic affair and at a later date a pathologic compression fracture of the vertebrae develops. The treatment is immobilization of the spine by conservative methods, if the deformity is slight, or else by the Albee fusion operation.

Kienboch's disease of the carpal scaphoid. Trauma has been found by Goldsmith and by others to enter into the causation of this condition. The original trauma, however, is never sufficient to produce a fracture, hence the fragmentation that occurs at a later date is pathologic. Injury to the local blood supply undoubtedly causes the osteoporosis. The prognosis is fairly good. If palmar flexion splints do not effect a good functioning hand, the bone should be excised.

Epiphysitis of the tibial tubercle or Osgood-Schlatter disease is seen most often in adolescent boys. The treatment consists of immoblizing the knee joint in 5 to 10 degree flexion for

approximately three weeks with guarded activities immediately afterward.

Local Pressure (Fig. 560).—Local pressure on bone may lead to necrosis and subsequent pathologic fracture. Some of these causes are: Pressure upon a contiguous tumor, pressure upon ribs, sternum, or vertebrae, pressure from a tight encircling wire

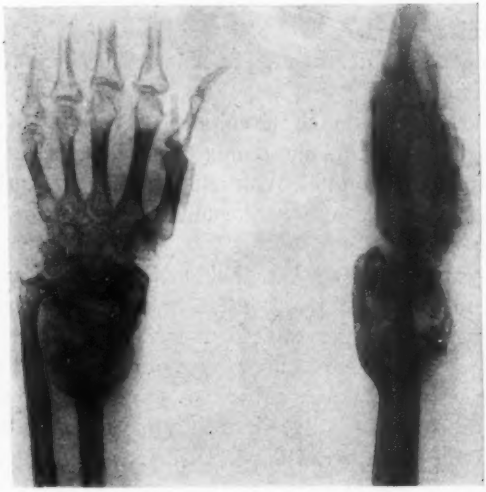


Fig. 560.—Giant-cell tumor, cystica fibrosa, chondroma or myeloma of the lower radius Male, nineteen years old, while receiving radiotherapy had to be splinted indefinitely. Note atrophy of disuse of phalanges. Had ulnar neuritis from pressure. *x*-Ray shows a large tumor involving the lower portion of the radius. It has the characteristic trabeculated or "soap bubble" appearance of giant-cell tumor. There has been a gradual expansion of the cortex which is everywhere intact. Note the abruptness with which the tumor stops in its upper portion, this indicating its benign character. There is a fracture through the head of the fifth metacarpal, evidently from atrophy of disuse. Further, note the pressure absorption in the ulna opposite the radial tumor.

or metallic band. The treatment consists of removal of the cause when such is possible. A personal case is recorded in which the fracture was due to pressure necrosis resulting from the application of a Parham-Martin band in another hospital. Garr has reported a similar case. Kilgore and Chamberlain have reported

"fibrosarcoma of soft parts causing pathologic fracture of the femur and giving an *x*-ray appearance of periosteal sarcoma." A double fracture of the mandible predisposed by an impacted molar has been described by Crich.

Fig. 561.—Pathologic fractures of the neck of both femurs due to Charcot's joints. Male, aged fifty-two. Slightly painful swelling for one year. No trauma. Walking on arrival. *x*-Ray shows evidence of an old fracture of the neck of each femur with marked upward displacement of the shaft. The acetabula are shallow and rarefied. The head of each femur is flattened and also shows rarefaction. These fractures never unite.

FRAGILITY DUE TO GENERAL DISEASE

Neuropathic (Fig. 562).—There are certain diseases affecting the central nervous system in which pathologic fractures occur. The most common are tabes dorsalis, paresis, syringomelia, spina bifida, hemiplegia and infantile paralysis.

The exact cause of predisposition to fractures in these conditions is not as yet known. No doubt there are several. It is known that injury to a nerve supplying a part causes trophic disturbances. An atrophic bone readily fractures. Allison and Brooks have shown that bone atrophy of disuse is a quantitative

rather than a qualitative chemical change. The chemical constituents of the bone making for strength and elasticity are deficient. The bone is fragile and it breaks easily. Other accessory factors, such as loss of pain and sensation, weak, atrophic musculature, and hypoplasia of bone, may play a part.

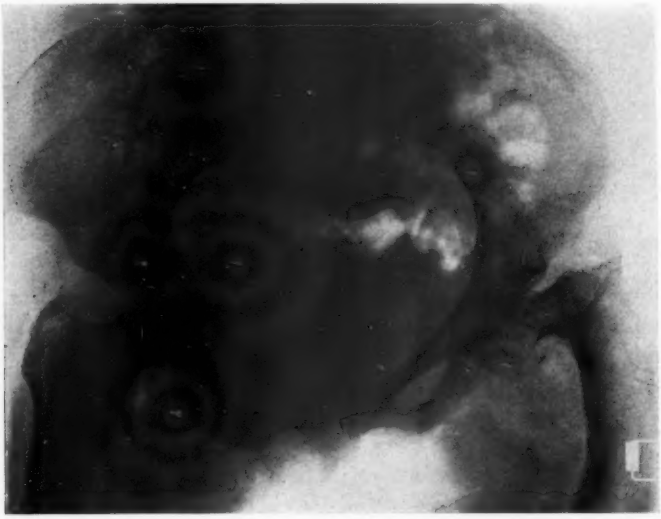


Fig. 562.—United pathologic fracture of neck of femur due to osteomalacia. Female, aged twenty-three years. Fractured hip when nine years old and femur when nineteen years of age. Concave cortex is thick. *x*-Ray shows an old united fracture of the neck of the femur with consequent deformity of the hip joint. There is marked decrease in density and a loss of the normal bone trabeculations as compared with the opposite femur. The shaft distal to the trochanters shows bowing with thickening of the cortex on its entire inner aspect evidently the result of faulty weight bearing in an osteoporotic bone.

Tabes Dorsalis and Paresis.—The greatest number of pathologic fractures in syphilitic patients occurs in tabetics and in paretics. According to Speed "the nervous system also has on bone an influence which predisposes to fractures. Neurotrophic influences in insanities, in paralyses and particularly in tabes must be considered. In the Cook County Hospital there are

each year 12 to 15 cases of pathologic fracture or fracture dislocation in tabetics. They are usually near the joints, accompanied by much bone change of a rarefying or hypertrophic character of typical Charcot joints, and are quite painless. Some patients present three to five fractures at the same time."

Cotton is of the belief that "fractures in tabetics are hardly spontaneous; they depend on incoordinate but powerful muscle action (as in fractures due to feats of strength), for, contrary to the common statement, the bones of tabetics are apt to be heavy and hard rather than atrophic."

Pathologic fractures in paretics usually occur late in the disease when these patients are bedridden and their paralyzed extremities are in an atrophic stage. False claims (French) of rough handling by attendants may be made. The femur is probably most often affected; occasionally the clavicle may also be affected. The diagnosis rests partly upon the history, physical findings, blood, or spinal Wassermann test, and the *x*-ray picture.

Treatment consists of proper immobilization, active antisyphilitic treatment, including large doses of iodides (Babcock), and drainage or dressings where a "mixed infection" osteomyelitis has occurred.

The prognosis is good as a whole, particularly where the disease is local. Speed agrees that most tabetics, even with Charcot's joints, heal though with deformed, but nevertheless functioning joints.

Syringomyelia.—Fractures in this condition are usually observed in the upper extremities while tabes which simulates it somewhat generally causes fractures in the lower limbs. The patient may not recall any traumatic cause, being insensible to pain. Schultzer reports a baker who fractured his arm during ordinary kneading of dough. The patient felt no pain, but the crepitation and shape of his arm attracted his attention. A patient of Bernhardt's also sustained a fracture of the ulna while at work, but continued to break stones. The next day he even carried water before consulting a doctor. Schlesinger reports a woman who heard a crackling sound while turning a bed cover. She then found that she had fractured both bones of her fore-

arm. Schultzer finds, curiously, that the right side is seldom affected, and the lower extremities rarely.

The fractures are apt to occur only in the late stages of syringomyelia. Normally, they heal quite rapidly or may require a long time, and pseudo-arthroses may form. The callus may be normal in amount or superfluous. It is the opinion of Schultzer that because of the loss of pain and muscle sense, the patient may not be aware that he is subjecting his muscles to any excessive strain. Similar instances are seen in normal individuals performing "feats of strength." Recent articles regarding pathologic fractures occurring in this condition have been published by Koch and others.

Spina Bifida.—Pathologic fractures in the lower extremity have been noted in cases of spina bifida. Its occurrence is not common. Its cause is attributed to bone atrophy as a result of the involvement of the lower spinal nerves in the meningocele. It may, however, be due to atrophy of disuse where the lower limbs are paralyzed. Where the neurotrophic condition has affected the growth of the bone, hypoplasia of bone rather than atrophy may occur. An eight-year-old boy under our present care illustrates this.

Union may be normal or delayed. The prognosis depends upon the etiologic factor. Treatment consists of immobilization and operative correction of the meningocele.

Hemiplegia.—Fractures due to bone atrophy and disuse usually occur in elderly hemiplegics. Often they are bedridden, though a defensive movement in an ambulatory case may result in fractures. The site of fractures is usually the anatomical neck or upper shaft of the femur. Occasionally the humerus suffers. Experience has taught us that the usual treatment of the past (plaster cast) is often inadvisable. As a general rule, the Russell apparatus is the most satisfactory treatment for the femur fractures. It is best to keep the patient in semi-Fowler position.

The reasons that have led us to adopt this form of treatment are: The frequent occurrence of hypostatic congestion and pneumonia, and decubitus in cases treated with a plaster cast, difficult nursing care, delayed or nonunion in many cases, regardless

of the form of immobilization, and finally economical and functional considerations. The patient is elderly and bedridden. The extremity is paralyzed and functionless, with or without union. Why, then, restore bony alignment in a paralyzed extremity at the cost of life from complications? The time will come when useless limbs will be amputated.

Infantile Paralysis.—In either infantile spinal paralysis or the cerebral paralysis of children, the growth of the bones in the affected extremity does not keep pace with the normal side. Bone hypoplasia and a retardation of bone growth may accompany bony and muscular atrophy. Willard mentions bone atrophy following poliomyelitis. Hassin and his associates have reported a number of cases. The question is unsettled as to whether the lack of regenerative power of bone in cases of paralysis is due to disuse or trophic disturbances. Putzu found experimentally that nerve trunk lesions have no effect on the formation of callus. Others have reported differently. Allison and Brooks show the effects of disuse in the production of bone atrophy. Tumpeer and McNeely have recently reported 2 cases of fractures in poliomyelitis.

Delayed union and refractures are apt to occur.

Osteoporosis of Disuse.—Osteoporosis of disuse is essentially bone atrophy due to prolonged immobilization or insufficient motion in a part. Bone stability is apparently due to proper nutrition supplied by an adequate circulation or tissue respiration. When either of the latter is interfered with, decalcification results. Hypomotility decreases tissue respiration. This condition is frequently observed in extremities that have been over-immobilized or have not functioned because of paralysis. It is encountered in the extremities of hemiplegics, infantile paralytics, deltoid, musculospiral, and circumflex paralysis, etc.

The prognosis is good if there is no accompanying nerve paralysis, though in the aged, senile changes, etc. must be remembered. As a rule, early mobilization, diathermy, baking, massage, and passive motions bring a good result. An unusual case is that of a young man (Fig. 560) who developed a pathologic

fracture of his fifth metacarpal as a result of prolonged immobilization of the wrist (and possibly from nerve pressure) while being given radiotherapy for a giant-cell tumor of the lower end of the radius.

Osteomalacia (Fig. 563).—Osteomalacia is an abnormal softening of the skeletal system. It affects adults primarily.

Fig. 563.—United pathologic fracture of femur due to osteomalacia. Same case as Fig. 562. Apparent bone density is due to reprint over exposure. Note bowing of femur, Wolf's jaw and Querstreffen lines. *x*-Ray (see last sentence in preceding illustration). Numerous Querstreffen lines are to be seen in the lower half of femur, indicating periods of arrested development.

So-called "juvenile osteomalacia" as a rule is osteogenesis imperfecta, with which it is often confused. In America, osteomalacia occurs most often in lactating women and is fairly common among those (Italian and Austrian) who are often

pregnant, have a poor diet, and suckle their young for one to two years in the belief that pregnancy can be avoided thereby.

War and famine osteomalacia was observed very often among the Central Powers during the great war. Maxwell (Peking, China) claims that osteomalacia is seen more often in India, Kashmir, and Northern China than in any other country. In the latter place there are at least 40,000 to 50,000 cases, mostly found in the uplands of Shansi and Shensi, in the middle belt of Kansu and in Manchuria. It is occasionally found in isolated cases all over the Republic of China. Hunger or starvation osteomalacia, as it is also called, is due to a long continued improperly balanced diet. Lack of fresh foods containing vitamins and absorbable calcium has been found to be the cause. Recently we have observed this condition in a twenty-eight-year-old female dietician, who, through voluntary dietary restriction to make herself thin, so succeeded that her tissues were that of a case of rickets. She was nearly 6 feet tall and weighed only 100 pounds. She was devoid of subcutaneous adipose tissue and the osseous system was quite porous. The fracture sustained was an intracapsular one of the femur with practically no pain. She has made an excellent recovery through immobilization, diet and ergosterol.

The condition when due to famine affects naturally both sexes and all ages. The diagnosis is generally made by *x*-ray. When the disease has progressed for a long time before fracture, bowing of the femora and pelvic deformity may be physically observable. The roentgenogram of the fractured and other bones reveals osteoporosis. The degree of bone porosity varies with the stage or severity of the disease. The bones are lacking in calcium and the blood content of calcium may be as low as 5 to 6 mg. (Mills and Feng). Bending of the long bones is often noted. It is due to weight bearing and bow-string muscle action.

The prognosis is favorable. Union may be delayed if metabolic needs are not appreciated. Refracture may occur for the same reason. In addition to immobilization, treatment should be directed to the causative factor. In the case of famine osteomalacia, a normal diet should immediately be given. It

should be reinforced by such articles that can quickly make up the deficient bone regeneration. Food products rich in vitamins C and D should be given. These consist of milk, codliver oil, egg yolk, orange and lemon juice, apples, and bananas.

Administration of parathyroid (Collip) may be given a trial. New calcium, easily absorbable, must be supplied by diet. Codliver oil, viosterol, ergosterol, ultraviolet rays, or sunshine, aid in better calcium absorption and deposition. In lactating or pregnant women, it may be advisable to terminate lactation or pregnancy and immediately institute the calcium increasing treatment outlined. The fetus in osteomalacia suffers with the mother. Osteoporosis and a diminished amount of calcium in the blood and umbilical cord are generally found. Maxwell, without terminating pregnancy, has been able to treat an expectant mother, cure her during gestation, and normally deliver her of a normal child. He uses diet, codliver oil, and irradiated ergosterol.

Cases due to starvation or underfeeding have been reported by Simon, Steiner, Hahn, and by Azenes.

Rachitis.—Rickets is observed most often in infants, but it may persist to adolescence. It is due to the lack of vitamin D. Negro children are probably most often affected. It is a hypovitaminosis, due to a poor diet on the part of the mother or an improper baby-formula. In infants the fontanelles delay in closing. A rachitic rosary is often present. The epiphysis and joints are enlarged. Curving of the long bones results. The bones are deficient in calcium and phosphorus and often contain an abnormal proportionate amount of magnesium and sulphur. The bones are fragile because they are soft. Fractures are similar to those in osteogenesis imperfecta. The *x*-ray reveals, however, cupped epiphysis in addition to bone porosity. Multiple fractures and recurrent fractures occur when the condition is not recognized or vigorously treated. The prognosis is good under proper treatment. Excessive callus is often the rule.

The treatment consists of proper immobilization and attention to diet and vitamin requirements. If the baby is still

nursing it should be taken from the breast and placed upon a proper formula. Orange juice, codliver oil, ergosterol, viosterol, etc. should be added. Schilowzen has demonstrated that avitaminos retard the formation of callus. When available, sunshine and ultraviolet irradiation are extremely beneficial. Scurvy may attend the condition as it did a recent one of our own.

Scorbutus.—Scurvy may occur at any age and in either sex. It is a hypovitaminosis and occurs when the diet is lacking in vitamin C. Imperfect osteogenesis results. Wasting, diarrhea, mucosal hemorrhages, periosteal proliferation, and osteoporosis are manifestations of the condition.

While it may occur among sailors, hunters, and explorers who exist largely upon canned or dried foods, pathologic fractures occur most often in infants and the young. The skull, ribs, costochondral junctions, and long bones are mainly affected by the disease. Fractures occur, as a rule, in the thigh, leg, and upper extremity. The diagnosis is made physically and by the *x*-ray. In the latter, subperiosteal hemorrhages with proliferation, or periosteal elevation is generally observed. As treatment is continued, the bone porosity decreases and new layers of periosteum are noted.

The prognosis is very good. Treatment other than proper splinting consists of supplying vitamin C. This is found in oranges, lemons, apples, and bananas. As the majority of fractures occur in infants or the very young, practically speaking, the treatment consists of the administration of orange juice in adequate quantities.

Metabolic Disturbances.—Diabetes.

Pathologic fractures occur among diabetic patients very rarely. It is questionable whether the fracture is a result of the metabolic disease or to associated disuse and atrophy.

Hyperparathyroidism.—Hyperplasia and also adenomatous changes of the parathyroid glands cause generalized osteoporosis. Pathologic fractures may result.

Compere has recently analyzed 12 cases of hyperparathyroidism including one of his own. Five or 42 per cent of these

developed fractures. Three or $33\frac{1}{3}$ per cent had had multiple fractures when reported. A recent personal case has had multiple fractures. Fifty-eight per cent of Compere's collected cases were females. The average age was thirty-seven years, the youngest being seven and fourteen years old, and the oldest fifty-nine years of age. The majority of them had been diagnosed as osteitis fibrosa. Eight of Compere's collected cases had an adenoma of the parathyroid gland. Another was not operated, but had bilateral palpable tumors (Duken's Case No. 2). The cases of Boyd, Milgram, and Stearns had a cystic adenoma. Wilder's cases had undergone malignant degeneration. The personal case proved to have a cystic adenoma of a parathyroid. The blood calcium is increased and chemical studies of the urine and feces show an excessive output of calcium. In addition to extreme generalized osteoporosis, hypotonicity of muscles and cystic degeneration of bones occur. Deformities are common.

The prognosis in the past has been hopeless, but recent operative interference has resulted in marked improvement. Without operation (parathyroidectomy) the fractures unite slowly and tend to recur.

In addition to immobilization and extirpation of the diseased parathyroid glands, the treatment should be directed toward better calcium deposition. Before operation and after operation the absorption of calcium and phosphorus may be materially benefited by the administration of irradiated ergosterol or codliver oil, heliotherapy, and diet. Future study and literature regarding this interesting subject will eventually clarify the situation.

FRAGILITY DUE TO HEREDITARY DISEASE

Osteogenesis Imperfecta (Figs. 564, 565).—Osteogenesis imperfecta is claimed to be an inherited diathesis of bone fragility, as many as 9 individuals being affected in four generations. Multiple fractures occur, more often in early life, almost exclusively before the thirtieth year.

Its etiology is little known and its terms are many. The various names confusing this condition are idiopathic osteo-

psathyrosis, fragilitas ossium, osteopsathyrosis, idiopathic fragilitas ossium, brittle bones with blue sclera, brittle bones, congenital rickets, juvenile osteomalacia, osteogenesis imperfecta congenita, osteogenesis imperfecta retarda, osteogenesis imperfecta, hereditary mesenchymic hypoplasia.

Patients suffering with this disease frequently have fractures from trivial traumata or muscular action. Cases are on record

Fig. 564.—Multiple pathologic fractures of right femur and bones of both legs due to osteogenesis imperfecta. Thirteen-month-old girl, one of twins. Both suffered similarly. *x*-Ray shows marked deformity of both lower extremities due to multiple fractures of the femora and tibiae. All the bones show the generalized decrease in bone density characteristic of osteogenesis imperfecta. These twins had been on orange juice and milk under the supervision of a children's clinic previous to admission with the fractures. In the hospital the treatment consisted of orange iuice, cod liver oil, heliotherapy, and traction.

where fractures have occurred *in utero* and during passage through the birth canal. The latter should be remembered because of its medicolegal aspects. Usually, though, multiple

fractures take place after birth. The *x*-ray reveals (except in the postadolescent age) extreme bone porosity and frequently many photographs have to be taken to secure a fair roentgenogram of the pathology. These patients frequently have blue sclerae. The long bones of the extremities and the ribs are mainly affected. In the pre-adolescent stage, the fracture lines

Fig. 565.—Same case as Fig. 564, sixteen months after intensive treatment. Both twins have had no further fracture for three and a half years. *x*-Ray shows practically normal lower extremities. The deformities have disappeared and there is little or no evidence remaining of the previous fractures. Note the marked increase in bone density.

have a peculiar appearance, they seem to result from a crumpling or bending action, with frequently an attempt to telescope on one surface. This peculiarity is probably due to the fact that the bone is so decalcified as to be actually softened. The bow-

string action of the powerful flexor and extensor muscles or torsion is then sufficient to crumple the softened bones. Despite the low calcium content of the bone, fractures heal quickly and with abundant callus. The blood calcium and phosphorus are usually normal or above normal as in hyperparathyroidism.

The immediate prognosis is good, but recurrent fractures and premature death often result.

The authors have had occasion to observe or treat some 8 cases of this condition. In one instance multiple fractures occurred in twins thirteen months old. In one family under observation, the condition has been present for four generations—a later report will follow.

Osteosclerosis Generalisata.—Osteosclerosis generalisata has been described by several writers. In this condition, all the bones seem to be abnormally hard or sclerotic. It is spoken of as marble bones. The bones are overcalcified (in comparison to osteogenesis imperfecta) and are entirely lacking in elasticity. The fracture line is often very straight (transverse) or steplike and resembles the breaking of limestone or marble. This condition occurs most often in the young. The etiology is not known, but it has been considered to be the result of a hypervitaminosis. The *x*-ray picture is pathognomonic, as the bones are revealed to be extremely opaque to the *x*-ray.

The immediate prognosis is good. No difficulties are encountered as a rule regarding union, though it may be slightly delayed. The ultimate prognosis is guarded because recurrences are the rule. The tendency to fracture usually disappears after the age of thirty (Babcock). Merrill has recently reported a case.

Gaucher's Splenomegaly.—In splenomegaly, due to Gaucher's disease (at least), rarefaction of bone takes place. Practically all cases which have recently been subjected to *x*-ray examinations have shown bone changes. The osteoporosis may be so great as to result in pathologic fracture. The lower ends of the femur seem to be most oftenest involved.

Welt et al. have recently reported 6 cases of this disease, 50 per cent of which developed pathologic fractures. The patients

complain of pains in the bones, stiffness, and limp. The long bones of the lower and upper extremity are chiefly affected. In addition to the splenomegaly, the symptoms may resemble osteomyelitis and be operated for the same as was the experience of Moschcowitz. The diagnosis is made by the blood findings, puncture, and *x*-ray examination.

The prognosis is not good. Splenectomy has aided a number of cases in relieving the anemia, hemorrhagic diathesis, and burdensome weight of the organ, but it remains to be determined how curative the procedure is.

FRAGILITY DUE TO CHEMICAL IRRITATION IN INDUSTRY

The absorption of certain chemicals in the body may lead to bony deposits of the metal and thence to necrosis. So-called "fragilitas ossium" among match dippers has been reported by Dearden. According to him, the bones of such workers contain an excess of phosphoric acid which combines with the preexisting neutral phosphate to form a slightly acid salt and thereby causing excessive brittleness of the bones, *i. e.*, phossy jaw.

Pearl-workers' disease is (DaCosta) due to an osteitis from chemical irritation. Tillmans claims that arsenic and pyrogallic acid produce a similar ossifying periostitis. Pathologic fracture due to the destruction of bone by mesothorium has been recorded by Martland. The fracture sustained was of the upper femur in a girl who painted watch dials with luminescent paint.

The treatment consists of eliminating the causative chemical when possible. The prognosis is generally good as to union, but poor as to complication.

ANALYSIS OF UNION IN PATHOLOGIC FRACTURES

Nonunion or various grades to excessive union may occur in different types of pathologic fracture or in the same disease.

The vast majority of pathologic fractures unite. Table 4 shows that union may occur in 87 per cent of the different diseases and 20 per cent may have excessive callus production.

TABLE 4

Pathologic condition.	Excessive.	Normal.	Union delayed.	Non.	Little known.
1. Cysts	..	x			
2. Enchondroma	..	x			
3. Osteitis fibrosa cystica	..	x	x		
4. Myeloma (benign, single)	..	x	x		
5. Carcinoma	..	x	x	x	
6. Sarcoma	..	..	x	x	
7. Endothelioma	..	..	..	x	x
8. Hypernephroma	..	..	..	x	x
9. Myelomata (malignant)	..	..	..	x	x
10. Acute osteomyelitis	x	x	x		
11. Chronic osteomyelitis	x	x	x		
12. Local pressure	..	x	x		
13. Neuropathic					
14. Springomyelia	..	x	x		
15. Spina bifida	..	x	x		
16. Hemiplegia	..	x	x		
17. Infantile paralysis	..	x	x		
18. Senility	..	x	x		
19. Disuse (porosis)	..	x	x		
20. Osteomalacia	..	x	x		
21. Starvation	..	x	x		
22. Rickets	x	x			
23. Scurvy	x	x			
24. Diabetes	..	x	x		
25. Hyperparathyroidism	x	x	x		
26. Osteogenesis imperfecta	x	x			
27. Marble bones	..	x	x		
28. Gaucher's disease	..	x	x		
29. Phosphorus	..	x	x		
30. Radioactive	..	x	x		
	6	25	21	5	3
	20 per cent	83.3 per cent	70 per cent	16.6 per cent	10 per cent
	A	B	C	D	E

Delayed union (but union nevertheless) may take place in 70 per cent. In only 16 per cent is nonunion the rule, though Bloodgood is aware of its occurrence in sarcoma, hypernephroma, and endothelioma. Ten per cent of this latter group are placed in the little known class as insufficient data and reported cases make this necessary.

SUMMARY

In fractures through benign tumors union is the rule. In cysts the fracture episode usually results in a cure of the cystic condition.

In malignant tumors union occurs. Hawley states that in carcinoma union is the rule. Bloodgood states that in metastatic carcinoma union rarely takes place. In Pancoast's experience 40 per cent of pathologic fractures due to carcinoma unite—with or without irradiation. In sarcoma Bloodgood states that union is almost unheard of, two doubtful cases in his report of twenty-one examples. In our personal series we have not sufficient data to form a conclusion. The cases usually die in bed of their metastases, the fracture being incidental.

In acute and subacute inflammatory conditions union is the general end-result, if the infection has early and adequate surgical treatment. In neglected cases, especially in adults, nonunion may occur.

In chronic inflammatory conditions union is the rule with excessive callus formation.

In fractures occurring in general disease, union is delayed or absent depending upon the course of the general disease. In rickets, osteomalacia, and scurvy proper, treatment results in union—osteomalacia frequently heals with excessive provisional callus.

Eighty-seven per cent of causative conditions are known to have union occur, in most of which union is the rule.

CLINIC OF DR. GEORGE P. MULLER

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SPLENECTOMY IN PRIMARY PERNICIOUS ANEMIA

WITH the advent of the widespread use of liver therapy and other protein extracts with or without vitamins, little attention has lately been given to some of the once popular and occasionally successful measures of treatment for primary pernicious anemia. It is our purpose on this occasion to bring back to general attention a valuable method lately discarded despite its evident success within certain indications, namely, the use of splenectomy.

Much has been said and done in the past since splenectomy was first advised by Eppinger concerning the relative values and indications for splenectomy. Thus the literature until 1927 and the advent of liver therapy contains many a series of splenectomy cases with varying results. Since the time of Eppinger there has been a marked improvement in the technic of splenectomy so that the operative mortality has been reduced to a minimum which did not exist previously. Thus the more recently reported series, the lower the operative mortality. Primary pernicious anemia before the liver therapy era presented such a hopeless and desperate prognosis that splenectomy, as Krumbhaar rightly says, was seized on all too often as a last resort and was greatly overdone. Thus early series revealed large operative mortalities and large numbers of unimproved cases. Nevertheless, as one traces this operation through the literature there is a definite evidence that an occasional and astonishing cure can be brought about, even in cases wherein all other measures fail. In 1923, in reviewing the literature again, he said that the pendulum of medicine had swung the other way and that splenectomy was

then neglected as much as it had previously been overdone. He presented at that time the total number of cases done, including the first report of the Mayo series, a total of 208 cases, of which 35 died within a month, or an average operative death rate of 16.8 per cent. Seventy-nine of this series died since operation, 26 were not improved, and 144 were improved. That splenectomy for this condition is at present neglected seems more true in many ways than at the time of Krumbhaar's paper, unless it can be proven conclusively that liver diet can entirely succeed it.

Since this summary by Krumbhaar many more cases have been reported, as follows:

Carr[3] reported one case with good immediate result, but complete follow-up was not obtained. Larrabee[12] reported one case followed by a prolonged remission. Spangler[20] also reported a case with complete recovery for seven years, at which time the patient was still in good health and the red cell count had risen from 1,140,000 to 5,400,000, with color index below one and an almost normal differential.

Walterhofer and Schramm[22] reported their results with splenectomy in the treatment of 16 cases of pernicious anemia. Only one patient survived as long as five years. Two others lived more than four years, and 2 more for over two years. The remaining 11 patients died in from two months to two years.

Holm[10] in 1922 reported a case of pernicious anemia in which after splenectomy the blood count increased from 760,000 to 1,725,000 in eleven months. He cited 85 cases compiled by Kriese, in which the benefit of splenectomy in pernicious anemia was remarkably constant; also Eppinger's 18 patients, 2 of whom lived for more than four years after operation and 6 more for more than two years.

Hitzrot[9] in 1922 reported 7 cases in which splenectomy was performed for pernicious anemia. In 3 cases death occurred within one year after operation; in 3 there was improvement for periods of one to four years; and in 1 operation was too recent to state the final result. The spleen was palpable in three of these cases, questionably palpable in two and not felt in two.

Yet in all cases it was larger than normal (265 to 500 Gm.). Hitzrot believes that, if the spleen is palpable in pernicious anemia, there is a definite indication for operation. Splenectomy is of special value, he has found in patients under forty-five with an anemia of the hemolytic type with hematogenous crises and periods of remission between these crises.

The greatest improvement occurred in cases with the most fragile red cells.

Schabort[19] in 1927 reported 4 cases from Guy's Hospital, London. Here operation was done because all other measures failed and the spleen was considerably enlarged in each. One died from subdiaphragmatic abscess; this patient's condition was so serious that death was inevitable in any event. Another showed striking rise in hemoglobin to over 90 per cent, but death occurred two months later from lobar pneumonia. In the other 2 cases the hemoglobin rose rapidly; one case lived four years and the other was still living five years later.

The Mayo series have been several times reported, the latest being by Giffin[7] in 1927. The original 62 cases were again reported, and of this group 3 patients were still living, one a year and eight months, 1 three years and six months, and 1 ten years after operation. Approximately 75 per cent of those who recovered from the operation lived less than three years, and 25 per cent lived more than three years. The average total duration of disease was seven and a half years.

Decastello[4] in 1928 reported 19 cases in which 2 are still alive and well, living for seven and a half and thirteen years. There were 6 operative deaths, 8 were vastly improved, of which 2 died in one year, 2 died in two years, 1 died after three years, 1 died after four and one-half years, and the 2 above are still living. Five were unimproved. The author advises splenectomy early, and feels that his high operative mortality is probably due to the lateness in disease at which the operations were done.

Meinertz[16] reported 8 cases in 1928, of which 4 died of operation, 1 died in three years, and 3 are living at one and one half, five and six and a half years postoperative. Blood curves

showed greatest increase after splenectomy in all cases, even though liver therapy was used in 1 or 2. Auxiliary measures were added in the shape of arsenic and transfusions.

Nargeshuber[18] in 1928 reported 11 cases, of which 9 were improved, 1 was an operative death and 1 was unimproved. He contrasted with this surgical series a series of 60 who had received liver therapy. Of the latter, 24 were improved, 30 died and 6 were unimproved. Of the entire series 48 died before the end of one year and only 2 were alive at the time of report. Of the 33 with nonoperative treatment in which remission was secured by liver diet, 14 died within the year, 5 lived more than five years, 3 lived more than two years, 1 lived more than one year, 4 lived about one year, and the fate of 6 was unknown.

Bohm[2] in 1928 reported one case in which splenectomy was done, who was living and well six and a quarter years later, while six similar cases without splenectomy died within a year.

These figures then, summarized from the literature and exclusive of the Mayo series, show a total of 70 cases of splenectomy in pernicious anemia since the summary of 208 cases by Krumbhaar. Of these, 11 died of operation; an average operative mortality of 15.6 per cent. Of the remainder, 55 were improved and only 14 unimproved. It is of greatest interest to note that 10 cases were still alive and well when reported at intervals of one to thirteen years following splenectomy.

A contrast of these results with the similar series of cases treated by liver therapy cited above by Narbeshuber in which 48 of 60 died within a year and only 2 were still living and well is also very interesting. It leads us to the belief that splenectomy still has a definite value, and in this we are supported by statements of others. Mayo,[15] for instance, says: "The liver feeding treatment of primary pernicious anemia is giving such good results that splenectomy is seldom indicated, but that it has a place in the treatment of primary pernicious anemia should not be forgotten." Narbeshuber states that liver diet and therapy is not a complete cure, and that in cases where the necessary indications exist, splenectomy still has a definite value. Giffin suggested that a combination of splenectomy with other therapy

might serve to almost completely ameliorate if not cure the disease.

Indications for splenectomy in primary pernicious anemia have been much discussed. It seems a consensus of opinion at present that it should be reserved for cases with high icterus index, increased fragility of red cells, with or without palpable splenomegaly. To this some of the German authors have added as an indication that splenectomy will often help when all other measures fail. If the theory of its action as advanced by Barker[1] and many others is by removing erythrophagocytes and thus decreasing destruction of already fragile red cells, one can readily see that in these cases of increased fragility splenectomy must be a valuable aid to any other treatment employed.

The patient I am now showing you illustrates the unusual type in which cure occurred for a considerable time after splenectomy. This case was reported by Dr. Brill, my former assistant, in the Annals of Surgery, 1927. She is a white woman, aged fifty-seven, who came to the University Hospital, service of Dr. Stengel in July, 1926, suffering with weakness and shortness of breath. This complaint had become increasingly severe for more than a year previously. She showed no evidence of cord changes except decreased vibratory sensation and a "pulling" sensation in her calves. She was, however, mentally disoriented and confused. Physical examination showed emaciation, jaundice, a systolic murmur of heart, a palpable spleen, but was otherwise negative. Clinical pathology as follows:

Fragility test: Hemolysis begins, .450; complete, .375. Van den Bergh test: Negative direct; 3.2 units indirect.

She was treated first by transfusions and liver diet. Her blood count improved at first as shown by illustration, but not until after splenectomy did this improvement become at all permanent. Immediately following splenectomy and cholecystectomy her Van den Bergh became normal, fragility reached normal limits, hemolysis beginning at .425 and ending at 0.300. She gained weight, her weakness disappeared and she was able to go about her work. Her blood count rose rapidly, aided perhaps by a rather inadequate liver diet. Since leaving the hospital

the patient has been symptom free, she has gained about 100 pounds in weight, her face has become ruddy, and her count has remained up. Only occasionally has she eaten liver; no more so than the average household would use. As you see her now she is rather obese, remarkably healthy in appearance, and her blood count is high. The illustration shows the progress of her blood count:

Mrs. L. M.

Date.	R. B. C.	W. B. C.	Hb. per cent.	Fragility.
7/ 3/26	1,160,000	6,900	23	0.450–0.375
7/ 4/26	Transfused 500 cc.			
7/ 7/26	1,470,000	11,200	34	
7/13/26	1,660,000	4,000	37	
7/18/26	910,000	4,000	27	
7/29/26	Transfused 300 cc.			
7/30/26	1,500,000	11,600	29	
8/ 7/26	Transfused 200 cc.			
8/11/26	Transfused 250 cc.			
8/12/26	1,850,000	3,300	30	
8/19/26	2,100,000	2,100	37	
8/27/26	Transfused 200 cc.			
9/ 2/26	Transfused 500 cc.			
10/ 8/26	1,640,000	4,600	40	
10/16/26	Splenectomy, cholecystectomy.			
10/21/26	2,310,000	6,900	37	
10/30/26	2,620,000	6,000	51	0.425–0.300
5/22/30	3,200,000	10,700	85	0.425–0.275
5/27/30	3,600,000	11,300	80	

The next case I am now showing you is Mr. R. O., a chauffeur, white male, age forty-seven years, who was splenectomized at Misericordia Hospital November 15, 1922. His chief complaint on admission was weakness which had begun some four years before admission, gradually increasing, with increasing shortness of breath for the last month. He also complained of some dizziness. Physical examination revealed a lemon-yellow skin, palpable spleen, and systolic cardiac murmur. The blood count showed a color index of 1.43, hemoglobin 43 per cent, red cells 1,490,000 and white blood cells of 5900, with a characteristic differential count and smear. Following transfusion the count rose to hemoglobin 45 per cent, and red blood cells 2,420,000, but quickly dropped again. Following splenectomy his count

rose to hemoglobin 63 per cent, red blood cells 2,940,000. When seen five years later he was symptom free and clinically cured, but his count was hemoglobin 24 per cent, red blood cells 1,370,000, a color index of .88. Since then he was started on liver diet. His blood count rose to 5,500,000, and he is able to do all work except the most strenuous.

The next case is really the most startling of all. J. L., a white male, aged forty-one, at time of operation was splenectomized at the University Hospital June 12, 1915, at which time his chief complaint was weakness of two years' duration, dizziness, and dyspnea with palpitation. He also had occasional vomiting and edema of the feet. Physical examination at that time showed yellowish pallor, icteric sclera, palpable spleen and liver, and edema of legs. His blood count was hemoglobin 25 per cent, red blood cells 1,300,000. There was a marked increase of urobilin output. Fragility of red cells was increased, hemolysis beginning at .525 and complete at .325. The spleen after removal showed hyperplasia and excessive pigmentation. After operation his urobilin output diminished to normal, and the blood count rose to hemoglobin 70 per cent, red blood cells 4,800,000, with a normal differential in two months. On discharge, the fragility of his red cells had also become normal. When seen by us in June, 1926 or eleven years after operation, he showed absolutely no symptoms of primary pernicious anemia. His blood count was hemoglobin 104 per cent, red blood cells 5,160,000 and white blood cells 7400, with no abnormality in differential. Bleeding and coagulation times were normal. One feature remained, however, namely, an increased fragility of red cells, hemolysis beginning at .600 and complete at .375. To the best of our knowledge this man is still alive and symptom free.

Besides these 3 cases I have done splenectomy on 5 more. The first of these, M. K., was a white woman of sixty-three, admitted to Misericordia Hospital September 9, 1926 and splenectomized October 12, 1923. Her chief complaint was nausea and vomiting of six months' duration, with numbness of one hand, dyspnea on exertion, and loss of weight. Physical examination

revealed pallor of skin, suspicion of jaundice of the sclera, systolic cardiac murmur. The spleen was not palpable. Clinical pathology: On admission, hemoglobin 55 per cent, red blood cells 1,600,000, white blood cells 4200. There was no free hydrochloric acid in the gastric content and the total acidity did not exceed six. The fragility of the red cells was normal, the urobilin test was negative. Following splenectomy and transfusion the blood count rose to hemoglobin 60 per cent, red blood cells 2,430,000, white blood cells 5900. At operation the spleen was found to be considerably enlarged, but it contained very little extra pigment on section. This patient did not materially improve thereafter, but died of her anemia, May 10, 1924. It is to be noted, however, that she did not present the typical indications which we now consider criteria for splenectomy, namely icterus, increased fragility and urobilin excretion.

The fifth case, Mrs. A. V., a white woman, aged forty-seven, was admitted to the University Hospital October 10, 1923 and splenectomized October 13, 1923. She entered the hospital with the chief complaint of progressing general weakness, soreness of the upper abdomen, lasting four years, after an acute illness with high fever, marked jaundice, nausea, vomiting, and diarrhea. Blood counts showed a progressive anemia despite transfusions. Physical examination revealed an adult white female with a lemon-yellow skin, well nourished. The heart showed a sytolic murmur, and the spleen was tender and palpable. The tongue showed glossitis and cord lesions were present as shown by loss of sense of position of toes and feet, and diminution of reflexes. Her blood count on admission was: Hemoglobin 38 per cent, red blood cells 1,710,000 and white blood cells 4800, with a typical picture in differential and smear. Following operation the blood count did not rise appreciably; hemoglobin 45 per cent, red blood cells 1,780,000, white blood cells 9700, and the patient died without marked symptomatic improvement December 23, 1923.

The sixth case, W. J., a white male, aged fifty-five, was admitted to the University Hospital September 4, 1924 and splenectomized October 7, 1924. His chief complaint was weakness

and nausea lasting one year. He also complained of dizziness, whirring noises in ears, tachycardia, and sore tongue. Physical examination revealed pallor with yellow tinge, blowing systolic murmur, but no palpable masses. Clinical pathology: Trace of urobilin in urine, gastric analysis, no free hydrochloric acid, total 20. Fragility test hemolysis begins at .450, complete at .350. Blood count, hemoglobin 15 per cent, red blood cells 1,120,000, white blood cells 1900. Several days later vibratory sense became impaired and symptoms of cord changes became apparent. The Van den Bergh was: Direct, immediate, and delayed biphasic, indirect 14.4 units. The blood count rose to hemoglobin 60 per cent, red blood cells 2,750,000, and white blood cells 7200 with a much more normal differential following splenectomy. However, the cord changes and symptoms rapidly progressed and the patient died May 19, 1925.

The seventh case, E. R., a white woman aged thirty-two, was admitted to the University Hospital November 13, 1925. Cholecystectomy and splenectomy were done November 14, 1925. Her chief complaints were weakness, loss of weight, and right hypochondriac pain with nausea and vomiting, all these lasting two years. Physical examination revealed a pallid yellowish skin, with icteroid tinge of sclera. The spleen was not palpable. Her blood count after several transfusions was: Hemoglobin 51 per cent, red blood cells 3,270,000, white blood cells 8200, with a nearly normal differential. Fragility test, Van den Bergh and urobilin tests were not done due to expense to the patient. The spleen at operation was enlarged to about twice normal size. Following operation this patient was considerably improved, but this improvement was only temporary and the patient died February 13, 1926.

The last case of this series was Mr. B., a white male, aged fifty-two, who was admitted to the service of Dr. Frazier March 23, 1918, and splenectomized March 23, 1918. His chief complaint on admission was weakness, shortness of breath, and palpitation. There is no record of a physical examination. Blood count showed hemoglobin 40 per cent, red blood cells 1,850,000, and white blood cells 8800. There was an excess of urobilin in

the urine. Following transfusion the count rose to hemoglobin 50 per cent, red blood cells 2,650,000. The spleen, after removal, showed considerable pigment and weighed 240 Gm. Following splenectomy the blood count rose to hemoglobin 69 per cent, red blood cells 2,890,000 with an almost normal differential. On October 7, 1918 this patient was still in excellent condition with a blood count about the same. We have no further records available, and do not know if this improvement were permanent or merely temporary.

It is to be noted that in this series there are no operative deaths. Three patients are still living and well at intervals from four to fourteen years. Four died within a year after operation and the fate of one is unknown. It is also interesting to note that of the cases cured, all have been symptom free and almost completely arrested; that the addition of slight amounts of liver after splenectomy may produce astonishing results not obtainable by transfusions and liver therapy before splenectomy. In all cases, transfusion was resorted to both before and after operation, lessening the risk of operation considerably, and liver diet added to the treatment in 2 cases with good result.

Conclusions.—A summary of the literature and the series of cases presented today leads one to conclude that splenectomy still has a very real value in the treatment of primary pernicious anemia, both as a primary treatment and as auxiliary to liver therapy and transfusion. When studying end-results since splenectomy first came into vogue, we reach the conclusion that in properly selected cases it is a very satisfactory method of approach, especially in supplementing other treatments, with some rather astonishingly cured cases. It is, of course, as Todd has said, impossible to evaluate the value of any treatment on survival only, since many cases survive over long periods of time without treatment, but it is nevertheless evident that the general average survival of our cases is greater than any of the other treatments previous to liver therapy, and when combined with this in the proper type of case, splenectomy promises much in the way of a more perfect control of the disease.

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CLINIC OF DR. EDWARD J. KLOPP

SERVICE OF DR. JOHN H. GIBBON

JEFFERSON AND PENNSYLVANIA HOSPITALS

INTESTINAL TUMORS

THERE are a sufficient number of interesting and unusual facts concerning most of the 5 cases of intestinal tumors herewith presented to warrant our discussion. The first 4 cases are carcinoma, 3 of the colon, 1 of the rectum. The 3 colon cases were under the care of physicians for months before operation. All except Case IV were operated upon fairly promptly when they came under the care of the surgeon.

Metastasis occurs relatively late in cancer of the colon. Butlin states that 55 per cent of the patients die while the cancer is still local, death being due to acute obstruction or infection. Cancers of the right half of the colon are comparatively benign and metastasize later than those of the left colon. There are two reasons for this: The tumors generally are soft and less malignant than the usual hard or scirrhus found on the left side; secondly the lymphatics are less well developed on the right side. Metastasis to the liver is found infrequently in carcinoma of the right colon.

Symptoms.—Increasing obstipation; associated with colicky pain in the abdomen, and alternating attacks of constipation and diarrhea is the history often obtained in these cases. Diarrhea is more apt to be found in distal colon carcinoma. Obstruction becomes evident earlier in left-sided lesions, because of the formed intestinal contents and the growth itself which is often a hard tumor involving the circumference of the bowel not unlike a cotton spool. When obstruction does exist in right-sided

lesions, the symptoms are more severe and there is relatively more toxemia.

Gaseous distention and borborygmus are frequently found in obstructive lesions, malignant or benign, of the colon. Jordan states that the appearance of these symptoms in any patient, except in a young individual with a neurotic tendency, should make one suspicious of malignancy of the colon or stomach. The presence of mucus or blood in the stool is helpful at times in making a diagnosis. Unfortunately, too often patients with mucus or blood, or both, are told that the symptoms are due to colitis and occasionally permit a malignant growth to become inoperable before it is recognized. Sigmoidoscopic examination will reveal mucous membrane changes, inflammation or ulceration, in the upper rectum or lower sigmoid, in cases of colitis. One can detect a palpable tumor in approximately half of the cases of malignant tumor when seen by the surgeon. Colicky pain is experienced most often when the lesion is located at the flexors or the distal colon. Later in the course of the disease, continuous pain may occur due to involvement of other structures. Tenderness as a rule is not a conspicuous symptom so long as the tumor remains free. When there is fixity tenderness may be quite marked.

Anemia, fever, loss of weight, and indigestion appear as secondary symptoms. Of these, anemia is most constant; in fact, it is nearly always present in cancer of the colon, being most marked when the cecum is involved. It has been observed that anemia bears a direct proportion to the size of the growth and bears no relationship to the extent of ulceration. A certain number of cases give no history of abdominal symptoms preceding the advent of sudden or complete obstruction.

An individual who has any variation in bowel habit and who may have unusual abdominal sensations, such as gaseous distention and borborygmus which continue longer than a few weeks, should be thoroughly examined for an intestinal lesion.

Malignant tumors are most frequent during the fourth, fifth,

and sixth decades of life. Several have been found at fifteen years of age and not a few during the third decade.

The roentgenologist has been of great assistance in diagnosing colon lesions. He frequently fails to detect a lesion in the rectum and pelvic colon. Here the growth can be felt or may be seen with the sigmoidoscope. Occasionally, a colon growth elsewhere is overlooked. All of us can cite such cases. Three years ago I saw a woman sixty years of age who had paroxysmal attacks of gaseous distention and increased constipation. *x*-Ray with barium enema failed to reveal any evidence of growth. Nothing abnormal was found on sigmoidoscopic examination. The abdomen was rotund and obese. There was no tenderness. There was moderate secondary anemia without a history of external evidence of bleeding. She was instructed to go South for a few months. Two weeks later there was acute intestinal obstruction and a palpable mass. The obstruction relieved itself spontaneously. On her return to the hospital there was another acute obstruction which had to be relieved by a cecostomy. There was carcinoma of the right transverse colon of the stenosing scirrhus type. Later a resection was successfully accomplished. Surgeons who do much colon work realize that a roentgenologist of more than average experience is needed to detect small lesions in the colon. Let it be emphasized that if the clinicians strongly suspect a growth, one negative *x*-ray report should not be accepted as final.

Rectal carcinoma is easily diagnosed. The early symptoms are change in bowel habit or sensation and bleeding. There is a strong tendency toward frequent rectal discharge which may consist of feces, mucus, or blood. The term "diarrhea" does not always convey the information we desire when obtaining a history; therefore we must be more explicit regarding the discharges from the anus. Pain and loss of weight are late symptoms. Digital examination with the patient in Sims' position will encounter the growth in 75 per cent of the cases of rectal carcinoma. The careful use of the proctoscope certainly will detect a rectal growth. A small section of suspected tissue should be removed for microscopic verification. A positive

Wassermann should not cause us to hesitate in making a positive diagnosis of carcinoma. One so often finds malignant changes in the oral and rectal cavities in syphilitics!

Operative Technic.—The reduction of immediate postoperative mortality and the permanent cures are due to the concerted efforts of the Mayo Clinic, Miles, Jones, Coffey, and more recently, H. H. Kerr. Many other names should be included in this list. The Kerr basting stitch method of intestinal anastomosis has greatly facilitated colon surgery. Two sections of gut can be expeditiously and aseptically joined. It may be used in all methods of joining the bowel. Those not familiar with the technic will find his splendid article in the Journal of the American Medical Association, vol. 81, No. 8, August 25, 1923, pages 641–647. The illustrations are beautiful and descriptive. Spinal anesthesia greatly facilitates resections of the colon and excisions of the rectum.

Case I. Carcinoma of the Rectum.—Pennsylvania Hospital, service of Dr. Gibbon. G. M., female, aged sixty years, widowed, was admitted from our Out-patient Department on March 17, 1930, complaining of (1) frequent and painful discharges from the rectum, (2) a lump protruding from the anus, (3) frequent and painful urination. She had noticed a hard lump at the anus a year ago which grew larger and larger. Five or six months ago there was bleeding at irregular intervals. For two months prior to admission she bled considerably from the anus, constipation became more marked, defecatory pain got worse, and the lump seemed to be larger while she was on her feet.

She never had any serious illnesses, operations, or accidents. There had been flatulence and eructations; frequent bilious attacks with nausea and vomiting; frequent urination for past two weeks (nocturia six to eight times), no hematuria. She had lost 10 pounds in three months and complained of weakness. She had two children, both now dead; menopause at forty-three. She worked as a chambermaid, waitress, and dressmaker since her husband's death in 1906.

On admission her temperature was 100, pulse 114, blood pressure 162/94. The skin and mucous membranes were pale; abdomen rotund, slightly distended, no tenderness, or palpable masses.

Rectal Examination.—There was a large, firm fungating mass protruding from and apparently involving the mucous membrane of the anus. Digital examination revealed a cauliflower-like mass surrounding the circumference of the rectum extending upward as far as the finger could reach.

Vaginal Examination.—The uterus and adnexa showed the usual postmenopausal changes. Through the posterior vaginal wall was felt a large,

hard, fixed mass, apparently in the rectum, but not involving the vaginal mucosa. The examining fingers seemed to sense the upper border of the growth.

There were several small, hard, discrete, movable glands in the left inguinal region and one in the right. The glands were not tender.

Biopsy of the growth revealed colloid carcinoma.

The blood Wassermann and Kahn were negative.

The urine and blood chemistry were essentially normal.

Blood count: hemoglobin, 83; red blood cells, 3,880,000; white blood cells, 6400.

Impressions.—On account of the duration and extent of the growth and the gastro-intestinal and bladder symptoms we suspected metastasis, therefore inoperable. Although colloid carcinoma is not as malignant as scirrhous or medullary. The patient was in constant distress, hence operation was suggested, believing that nothing but a colostomy could be done which probably would have afforded some relief of symptoms.

Operation.—March 26, 1930. Spinal anesthesia. Through a left paramedian incision the abdomen was explored. There was no palpable evidence of metastasis to the liver. The lymph nodes and peritoneum also seemed uninvolved. Excision of the rectum was decided upon following the method of Coffey. The growth could not be felt through the abdomen until the pelvic dissection had been begun. As the exploratory and operative incision had been made to the left of the midline, the permanent colostomy was established through the upper end of the incision and not through a separate opening. The wound became infected. I had not done this in any cases before and doubt if it is a good plan. The Payr clamp on the sectioned end of the sigmoid used as a colostomy was allowed to remain seventy-two hours, there having been no abdominal discomfort or distention until twelve hours prior to its removal.

Second Stage of the Operation.—April 2, 1930. Spinal anesthesia. Excision of the anus, surrounding tissue, and distal rectum with the growth and inverted bowel. It is amazing how easily this is done if the first stage has been satisfactorily accomplished. The large cavity thus left was packed with vaselinized gauze.

The colostomy functioned satisfactorily. The abdominal wound drained pus for three weeks. Hypodermoclysis of normal saline solution was used for several days following the first stage operation in order to maintain the fluid balance.

Laboratory report by I. J. Wolman: The specimen consists of the terminal 15 cm. of rectum which has been opened. The mucosal aspect of the distal 6 cm. is red, coarsely granular, and coated with bloody mucus. The circumference here is 9 cm. Very cystic areas can be seen just below the surface. The lower extremity of this ceases abruptly in a wavy line, to be immediately replaced by the normal squamous epithelium of the anus. Just before this line of transition the granular surface shows a line of polypoid overgrowths which, on section, present gelatinous translucent nodules imbedded in gritty fibrous tissue. The upper margin of this granular surface is jagged and irregular. About it lies pale smooth intestinal mucosa. The

lumen here is dilated, having a circumference of 8 cm. The sigmoid pole of the specimen has been cauterized and is necrotic. The reverse outer aspect of the specimen shows a layer of fat and fascia adherent to the rectal wall. On section this shows no scarring or neoplastic tissue. Several small nodes near the anal margin are soft and pinkish-gray.

Microscopically.—The nodular appearance of the terminal rectum is produced by masses of large vacuolated malignant epithelial cells which lie in the submucosa and muscularis. The mucosa is ulcerated away. These cell masses are often degenerated and form islets of mucoid matter in which the cell margins are faintly visible. They are separated by strands of fibrous tissue containing polymorphonuclears and plasma cells. The individual epithelial cells are very large and have a coarsely vacuolated pale-staining cytoplasm; their nuclei are eccentric oval and hyperchromatic; no "signet-ring" formations.

At the anal border these cell masses underlie the squamous epithelium, which is thickened and acanthotic. At the opposite border the mucosal glands show marked secreting activity, practically every columnar epithelial cell being of the goblet-cell type. The muscularis does not seem invaded to its entire extent, but tumor extensions are found in the lymphatics of the contiguous fat, surrounded by lymphocytes. A contiguous lymph node shows an acute inflammatory reaction, but not metastatic tumor.

Diagnosis.—Colloid carcinoma of rectum.

The patient left the hospital on June 7, 1930, with the perineal wound almost healed and able to care for herself.

Comment.—An assistant in charge of the Out-patient Department had asked permission to refer the patient to a "home for incurables." The duration and size of the growth made one suspect inoperability. At operation, I was agreeably surprised that metastasis was not demonstrable. Spinal anesthesia greatly facilitated the first stage Coffey operation. This type of operation is much more easily carried out in women than in men.

Case II.—Carcinoma of the Sigmoid.—Jefferson Hospital. Referred by Dr. Martin E. Rehfuss.

R. D., Italian, aged forty-four years, restauranteur. Admitted to the hospital February 8, 1930, complaining of pain in the lower abdomen radiating to the rectum, with frequent bloody discharge and constipation.

He had gonorrhea at forty-three; nothing else of note in his personal history.

In June, 1929 he noticed blood in the stools. He soon had six or seven evacuations daily; this continued until the operation and consisted of bloody mucus. The bowels were constipated, requiring the daily use of agarol. Abdominal discomfort increased each month. In January, 1930 voiding of urine would temporarily relieve the abdominal cramp and rectal discomfort.

He had lost 7 pounds, which was attributed by his family physician to the low carbohydrate diet that had been ordered.

His mother died of cancer of the stomach at sixty-three years of age.

The family physician treated him for hemorrhagic colitis from June, 1929 until January, 1930, when the patient became discouraged, whereupon Dr. Rehfuss was consulted. On passing the proctoscope 18 cm. a mass was encountered, but no growth could be seen involving the mucosa. An *x*-ray study by Dr. Manges with an opaque clysma revealed an irregular narrowing at the upper one third of the sigmoid. The narrowed portion was approximately one half the normal diameter of the sigmoid and showed enough irregularity to warrant the diagnosis of an infiltrating new growth. He was unable to force the enema beyond the hepatic flexure. The procedure caused a good deal of pain, indicating an inflammatory process about the growth.

On physical examination there was a palpable, firm, slightly mobile, moderately tender mass in the left lower abdominal quadrant. The cecum was readily palpable and enlarged. The descending colon was easily felt. The liver and spleen were not palpable. The skin was a muddy pale color, due more to his race than to anemia. Dark blood was found on the glove at each digital examination of the rectum.

Blood Wassermann, negative.

Hemoglobin, 78 per cent; red blood cells, 4,400,000; white blood cells, 10,400.

Blood chemistry and urine were essentially normal.

The blood count was far better than one would expect it to be from the appearance of the pale skin and mucous membranes and from the history of prolonged bloody discharge from the rectum.

Operation.—February 10, 1930. Spinal anesthesia.

Preoperative Diagnosis.—Carcinoma of sigmoid.

A midline incision was made below the umbilicus. The liver revealed no evidence of surface metastasis. The mass in the sigmoid, about the size of a hen's egg, was adherent to the bladder. The adjacent mesenteric glands were enlarged. A portion of the wall of the bladder was excised. The defect was closed with three rows of catgut sutures. The growth could then be brought into the wound, but not outside of the abdominal wall, due to a short mesosigmoid. After liberating the lateral peritoneum the growth was easily brought out. The Mikulicz type of operation was decided upon. The afferent and efferent loops of bowel was sutured together leaving the growth and a goodly portion of normal bowel on each side protruding from the abdominal wall, through a second incision made along the lateral border of the left rectus. The bowel was sutured to the peritoneum. The midline incision was closed and sealed with flexible collodion over several layers of gauze. This in turn was protected with a liberal piece of rubber dam. One week later the growth was excised with the electric cautery. Three days later a clamp was applied to the spur between the lumens of the afferent and efferent loops of bowel. The clamp produced necrosis in four days and was lifted away without any traction. The final closure of the fecal fistula was made on April 17, 1930. A previous attempt at closure had failed. He was discharged from the hospital on April 21, 1930.

Histologic diagnosis of the growth by Dr. B. L. Crawford was adenocarcinoma of the sigmoid. No evidence of lymph nodes was observed in the tissue.

Comment.—We do not believe that the Mikulicz type of operation is the one of choice in cases of carcinoma of the sigmoid unless the mesosigmoid is long and readily permits of bringing out of the abdomen ample portion of bowel so as to get well beyond the lesion. In this case, the sigmoid was mobilized with some difficulty. There were palpable glands in its mesentery, though none were found in the specimen by the pathologist. I thought at the time of the operation that the mesentery containing the enlarged glands was well outside. Now we are concerned about two things—were the glands malignant and were they left behind? The Mikulicz operation was decided upon for four reasons:

1. The lesion had existed a long time (eight months with marked symptoms) in a young man.

2. The growth was adherent to the bladder, making recurrence likely.

3. The mesenteric glands were enlarged, though perhaps not malignant.

4. Considering the above conditions, it was felt that an operation for removal of the growth attended with the lowest mortality was the one of choice.

An adherent carcinoma of the colon does not necessarily indicate that recurrence is certain and that resection should be abandoned. In August, 1929, I operated upon a man fifty-five years of age with carcinoma of the sigmoid. He had vague abdominal symptoms for four years, and the last year the symptoms were so definite as to make one suspect a growth. At operation the growth was found densely adherent to the iliac fossa. A colostomy was done without disturbing the growth. The midline incision became infected. Subsequently an extensive abscess developed in the deep structures of the left thigh. He died in four months from sepsis. Autopsy showed an infection surrounding the growth with an extension into the thigh, but

no metastasis. We erred by not doing a preliminary colostomy, followed by resection of the growth.

Case III. Carcinoma of the Cecum with Enlarged and Adherent Lymph Nodes.—J. H. L., white male, aged sixty-nine years, was referred by Dr. C. H. Turner.

He was admitted to the Jefferson Hospital April 8, 1930, complaining of soreness in the right lower abdomen, loss of strength and weight, and constipation. He had pneumonia at twenty-two, and typhoid fever at thirty-five years of age. There had been no injuries or operations; no history of venereal disease; no history of malignancy in the family. The bowels were habitually constipated, requiring frequent use of laxatives. His best weight was 169 pounds in 1919; weight on admission was 126 pounds.

Fig. 566.—Case III. Carcinoma of the cecum showing extensive involvement. There were very large lymphatic glands immediately adjacent to the growth.

In January, 1930 he noticed a dull pain in the abdomen which was not definitely localized at first, but later shifted to the right lower quadrant. There was intermittent gaseous distention with "rumbling of gas." He believed his constipation became more marked. For a month pripor to admission there was frequent nausea, and vomiting which would occur once in two or three days.

The skin and mucous membranes were pale. There was marked emaciation, and he appeared like a man starving. The liver extended 3 cm. below

Fig. 567.—Carcinoma of the cecum with involvement of mesenteric glands.

the ribs. In the right lower quadrant was a firm, partly tympanitic, apparently fixed mass, the size of a woman's fist. Palpation of the mass was painful. Blood Wassermann was negative. Hemoglobin 65 per cent, red blood cells 3,800,000, white blood cells 10,200.

Colon *x*-ray with an opaque clysma showed an irregularity of the cecum which was diagnosed by Dr. Leon Solis-Cohen as carcinoma of the cecum (Fig. 566).

Operation.—April 11, 1930. Spinal anesthesia.

The abdomen was opened through a right Battles' incision. The liver seemed free from metastasis. There was an excess of clear peritoneal fluid. The cecum was involved by an infiltrating growth approximately 8 cm. in its long diameter. Immediately adjacent and densely adherent to deep structures was a large, hard mass of lymph nodes. The growth in the cecum

Fig. 568.—The small Payr clamp applied to the ileum with the introduction of the Kerr basting suture. As the clamp is removed the suture is drawn taut closing the end of the bowel without leakage, and appearing somewhat as shown in the colon above.

itself did not seem to be very adherent. Resection was decided upon. The cecum, ascending colon, and terminal ileum were easily freed by incising the lateral peritoneum. The mass of glands was adherent to the iliac vessels for a distance of 3 cm. Separation was rather tedious. After this was accomplished the resection of the cecum, terminal ileum, and ascending colon was accomplished with comparative ease. End-to-end anastomosis was done

according to the basting method of Dr. H. H. Kerr (Figs. 567–571). A small rubbered-covered drain was inserted for three days. The patient made a nice recovery and left the hospital May 10, 1930.

Histologic diagnosis by Dr. B. L. Crawford: Adenocarcinoma of the anaplastic type. The enlargement of the lymph nodes was due to metastasis.

Comment.—This seemed like an inoperable case. The patient was aware of a growth; he had constant discomfort, frequent

Fig. 569.—The basting suture in both ends of the bowel to be joined.

nausea, and vomiting. He now is fairly comfortable, appetite good, no nausea or vomiting, and has spontaneous bowel movements daily. Anyone interested in the Kerr technic of intestinal anastomosis should read his article in the Journal of the American Medical Association, August 25, 1923.

Fig. 570.—The method of end-to-end anastomosis without the use of clamps substituting the Kerr basting stitch.

Fig. 571.—The anastomosis completed and withdrawal of the basting suture.

Case IV. Carcinoma of the Cecum with Longstanding Intussusception.—Service of Dr Gibbon, Pennsylvania Hospital. N. C., male, aged thirty-two years, was referred by Dr. B. Segal. Admitted March 15, 1930. Chief complaint, intermittent generalized abdominal pain.

On August 7, 1928 I saw him with Dr. Segal, at which time he complained of severe abdominal pain localized in the right lower quadrant. He had had slight pain in the same location for two weeks, not severe enough to keep him from work as a tailor. The temperature was 99.4 F.; pulse, 80; leukocyte count, 9000.

He was admitted to the Jefferson Hospital the same evening.

Blood count, August 8th: hemoglobin, 74 per cent; red blood cells, 3,850,000; white blood cells, 8800.

Wassermann negative; Kahn negative.

Urine essentially negative.

There was slight rigidity and moderate tenderness over the right lower rectus. A diagnosis of appendicitis was made. Operation August 8th. Nitrous oxide-ether anesthesia.

The abdomen was opened through a right Kammerer incision. The appendix was large, much thickened, and moderately inflamed. The cecum was definitely indurated for an area of 5 cm., which seemed more or less continuous with, or an extension from, the appendix. The clinical diagnosis was appendicitis, probably tuberculous, although there was no tubercles demonstrable. The postoperative recovery was satisfactory; he left the hospital on August 20, 1928.

Histologic examination by Dr. B. L. Crawford (this is given in detail on account of the unusual gross appearance and the subsequent course of the case).

Specimen consists of an appendix, measuring 5 by 1 cm. Its surface shows many small, injected capillaries, but is smooth and glistening. On section the lumen is patulous and the wall appears thickened.

Formalin fixation.

Histology.—Sections consist of tissue from the appendix. The lining epithelium shows a marked increase of goblet cells, the lymphoid tissue is hyperplastic. In the mucosa there are many cells of inflammatory origin; these include eosinophils, plasma cells, polymorphonuclear leukocytes, and round cells. Beyond this area of hemorrhage in the muscle area there is some inflammatory change in the cells. The serosa appears to be thickened, and here and there are small aggregations of cells situated about vessels. These cells are lymphocytes and round cells. The type of inflammatory change is unusual, but there is nothing in the section which can be definitely construed as a tuberculous lesion. The whole appendix was sectioned in the hope of finding the tuberculous lesion.

Diagnosis: Subacute appendicitis of unknown etiology.

He seemed to be in splendid health and had no abdominal discomfort for six months following the appendectomy. Then he began to have paroxysmal abdominal pain which started in the right lower quadrant and gradually extended all over the abdomen. A daily dose of mineral oil kept the bowels active. Antispasmodics seemed to afford relief for several months.

Heliotherapy and various forms of physiotherapy were employed. Ultimately the pain recurred so often and got so severe that he could work only one or two days a week.

He was admitted to the Pennsylvania Hospital on March 15, 1930. A week before that he began to have diarrhea. The day of admission and the following day he vomited large quantities, about a pint, of dark green fluid. The abdomen was tender immediately to the right of the umbilicus. There seemed to be slight distention of the cecum, but the abdomen as a whole was

Fig. 572.—Case IV. (Dr. David R. Bowen.) Barium enema before operation. Note the abrupt end of the enema at about juncture of middle and distal third of transverse colon. I believe that the outline of the intussusception is well shown. It was at that time mistaken for gas.

flat. The cecum was distinctly palpable at times and impressed one as being definitely thickened. Again at other examinations one would have great difficulty in finding it. Belladonna waa administered. Vomiting ceased for a few days, then a gastro-intestinal *x*-ray with an opqaue meal was attempted. This failed as he vomited the material, so that very little of the barium reached the intestines. Vomiting and intense pain now became almost a daily occurrence. The vomitus contained bile, but no intestinal contents. An *x*-ray of

the colon was done with an opaque enema, the first was unsatisfactory because the patient had too much pain and tenesmus at the time. A second effort gave splendid results, showing the intussusception with almost complete obstruction (Figs. 572, 573).

On April 1, 1930 a spherical mass was felt in the umbilical region. It was freely movable, tympanitic, moderately tender, firm, and approximately double the size of the average cecum.

Operation.—April 4, 1930. Spinal anesthesia.

The abdomen was opened through a right paramedian incision. There was an increase of clear peritoneal fluid. The cecum, terminal ileum, ascending colon, and portion of the transverse colon had telescoped or intussuscepted so that the mass was to the left of the midline, and most of it under the left

Fig. 573.—Case IV. (Dr. David R. Bowen.) Barium enema, sitting as Fig. 571. Note that the negative shadow has been pressed a little farther upward. In other words, that it is farther from the splenic flexure. I believe that this was due to forcing back of the intussusception.

costal stage. At first it was thought that we had merely encountered a chronic intussusception and that after reduction had been effected everything would be satisfactory. The proximal portion of the intussusceptum was easily withdrawn. The proximal portion of the colon and the cecum could not be withdrawn from the intussuscipiens. The mesentery of the intussusceptum was much thickened, though not acutely inflamed, and contained many enlarged, fairly firm lymph nodes. The bowel also was greatly thickened. It was because of this that one could not definitely determine the cause of the ileocecal intussusception, or the condition of the cecum. Not knowing the condition of the cecum it was considered unwise to incise the border or shoulder of the intussuscipiens in order to effect reduction. A resection was done in the usual manner, including the terminal 6 inches of ileum, cecum,

and ascending colon. The mesentery was sectioned close to its base to include all of the enlarged glands. The bowel was crushed with Payr clamps and divided with the electric cautery. The sectioned end of the colon was closed with two purse-string sutures using catgut. The end of the ileum was joined to the side of the colon, using the Kerr basting suture on the ileum and a clamp on the colon in making the anastomosis. A double row catgut suture was used. Immediately after incising the clamped colon intestional contents escaped, soiling the field of operation. It was wiped with an alcohol sponge. The soiling continued, and at least eight or ten alcohol

Fig. 574.—Case IV. (Dr. David R. Bowen.) Barium enema after the operation. Note that the barium has passed the anastomosis and that a considerable amount of it appears in the ileum.

sponges were used. The abdomen was closed with a small rubber-covered gauze drain. There was no infection, in fact, no drainage at all. Recovery was uneventful (Fig. 574).

Histologic report by I. J. Wolman: The specimen consists of a portion of intestinal tract taken from the neighborhood of the ileocecal junction. It consists of that portion of the intussusception which is irreducible. When the lumen is exposed, thereby obliterating the intussusception, one recognizes that the specimen consists of the terminal 15 cm. of ileum, cecum, and 10 cm.

of the ascending colon. The appendix is absent, having been removed at a previous operation. The ileum is somewhat dilated and its wall hypertrophied. The mucosa is pink and coated with bloody mucus. At the junction of the ileum, cecum, and ascending colon, there is an oval nodular swelling on the wall, 8 cm. in length and 5 cm. in diameter. This is located beneath the mucosa of the ascending colon, which, however, has been partly ulcerated on the exposed surface. This ulcerated portion grossly granular mucous covered, somewhat eroded surface, and it is attached to the wall at one pole, the other pole pointing upward along the axis of the ascending colon; where the free end lies in contact with the colon wall a triangular area of erosion of the colon mucosa has occurred so that the submucosa, congested, is exposed. The ascending colon seems somewhat dilated and its wall hypertrophied. The mucosa, however, is very pale. No evidence of infarction or gangrene of the specimen is evident. When the nodule is sectioned it is found to have a firm core which resists the knife. It shows superficial soft circular areas embedded in the firm whiter scar tissue. Lower down one sees only scar tissue and yellow fat lobules; on the external aspect the pole is covered with congested connective tissue. A few glands are found which are very small, soft, homogeneous, and pearly gray.

Microscopically: The superficial part of the large egg-shaped growth shows a zone of narrow branching glandular spaces, which discharge their mucoid secretion on the surface. These glands are irregular in arrangement. They are lined with columnar epithelial cells closely packed, but orderly arranged; a basement membrane, however, is lacking. Mitoses among these epithelial cells are occasionally seen. The supporting stroma is smooth muscle, derived apparently from the muscular intestinal coat. Its interstices are much thickened and scarred; they contain plasma cells and lymphocytes in abundance. Eosinophils also lie among the glands. In some areas the masses of glandular spaces are necrotic; in others, some of the spaces are distended and filled with mucous secretion. Nowhere has invasion of the intestinal wall beyond the muscular layer occurred A retrocecal lymph node shows chronic inflammatory changes in the form of hyperplastic germinal centers, sinus dilatation, and reticulum-cell proliferation. The colon and ileum show hypertrophied muscle walls, lymph follicle hyperplasia, and glandular activity.

Diagnosis: Adenoma malignum of cecum causing intussuception.

Comment.—We were slow to recognize the serious lesion. Perhaps the condition in the cecum at the time of the appendectomy was carcinoma instead of chronic inflammatory, as we had diagnosed it. The appendix was definitely inflamed, which was verified by histologic examination. One so often finds cecal inflammation in association with appendicitis. Occasionally, a surgeon will find carcinoma of the cecum associated with appendicitis. The first case of cecal carcinoma I operated upon was

a woman of seventy-one who had a perforated appendix with a fecalith in an abscess containing 4 drams of pus. A resection was done in the presence of pus. The family physician thought that she would not submit to a second operation for removal of the growth. Infection occurred, a fecal fistula formed, which closed spontaneously in four weeks. The patient lived comfortably for ten years, then died of cardiorenal disease.

One cannot tell when intussusception occurred. We believe that it became more pronounced when the symptoms got worse, about a week before he came to the hospital. At no time were we able to demonstrate a sausage-shaped mass which is characteristic of intussusception. The distended, slightly tender, tympanitic firm bowel was supposed to be due to chronic inflammation.

The pathologist was unable to find any evidence of malignancy in the mesenteric glands. The patient is perfectly comfortable today, June 27th.

Case V. Acute Intussusception of Small Bowel Due to a Polyp (Enteric or Ileal Variety).—L. J., female, aged forty-four years, was referred by Dr. Martin E. Rehfuss. She was admitted to the Jefferson Hospital on November 19, 1929, complaining of (1) pain in the upper abdomen, (2) hemorrhoids, (3) belching, (4) pain in the left shoulder and arm, (5) constipation, (6) slight dyspnea.

Her father died of cancer of the larynx at fifty-eight years.

She had five children.

Tonsillectomy in 1897; appendectomy in 1911 following a second acute attack.

History of Present Illness.—For the past few years has been subject to indefinite pain in upper abdomen. In October, 1928 had an attack of acute pain in upper abdomen, which pain required morphine to quiet her. This attack was followed by jaundice and clay-colored stools. One month later had another similar attack, this attack being accompanied by emesis, the pain was severe, and across the upper abdomen, beneath the costal edge. This attack was also followed by jaundice and clay-colored stools. Patient then went to a hospital where she had numerous duodenal drainages and *x*-rays, and nothing definite was found. Was put on a diet, to which she adhered for six months. Since last November has had no acute attacks of pain, but has had indefinite distress in upper abdomen, belching, and pain in left shoulder and arm, which symptoms have persisted throughout. Her constipation is most obstinate, moving only after resorting to cathartics.

Since her last confinement nine years ago has had hemorrhoids from

which she bleeds quite a bit. For the past three months has noticed that she becomes dyspneic upon going up stairs, or on any exertion.

Blood examination (11/19/29): Hemoglobin, 61 per cent; red blood cells, 3,960,000; white blood cells, 9100, color index, 79.

Polymorphonuclears, 5.1 per cent; small monoculars, 6 per cent; eosinophils, 5 per cent.

Blood chemistry practically normal.

Urine essentially negative.

Gastro-intestinal *x*-ray by Dr. Farrell revealed no evidence of organic disease of any portion of the gastro-intestinal tract. The gallbladder gave a normal response to the Graham test. The only abnormality was tenderness in the cecal region which was associated with a visibly fixed appendix.

There was copious bleeding with nearly every bowel evacuation. The skin and mucous membranes were pale. Digital examination of the anal region revealed large internal hemorrhoids. Operation December 5, 1929. Nitrous oxide-oxygen anesthesia.

The hemorrhoids were removed by the clamp and cautery method. She left the hospital on December 15, 1929, with no more bleeding from the bowels.

She gained color, strength, and weight and was quite comfortable until January 23, 1930, when she was suddenly seized with severe generalized abdominal pain. The pain was paroxysmal, cramplike, and radiated to the back and shoulders. She vomited all liquids and food; there were no bowel movements after the onset of pain.

She was readmitted to the hospital on January 26, 1930. The abdominal pain was constant with paroxysmal exacerbations. The abdomen was distended, peristalsis was hyperactive with a high-pitched note. There was a sausage-shaped mass extending from 2 inches to the right of the umbilicus upward toward the left for a distance of 10 cm. The mass was freely movable. The vomitus consisted of intestinal contents.

Pulse 98; temperature 100 F.

Diagnosis: Acute intestinal obstruction.

Operation.—January 26, 1930. Nitrous oxide-oxygen-ether anesthesia.

The abdomen was opened through a midline incision below the umbilicus. There was an excess of clear peritoneal fluid. An intussusception of the small bowel was found, apparently of the lower jejunum and upper ileum. The invaginated bowel was easily reduced, and in so doing approximately 100 cc. of dark, foul-smelling fluid escaped from the encasing sheath. There was an opening in the intussusception 1.5 cm. in diameter, with sharply defined punched-out margins, probably due to gangrene. It was through this opening that the fluid had escaped. The defect was closed with two rows of catgut sutures. There were five other gangrenous areas which had not perforated, the serosa had not yet given away. One of these areas was 6 cm. long. All of these were infolded with catgut. Within the lumen of the intussusceptum was found a polyp which had to be removed through an incision as it was too far from the opening or the other gangrenous areas to utilize for its removal. Many of the mesenteric veins were thrombosed. Forty cm. of the gut had invaginated.

The gallbladder and appendiceal regions were not explored. The oper-

ative field was carefully wiped with moist sponges and the abdomen closed without drainage.

Smears from operative field showed many pus cells, many gram-positive cocci.

Culture: Staphylococcus albus, Bacillus coli.

The abdominal wound became infected, but healed in eighteen days; her recovery otherwise was satisfactory.

Histologic examination by Dr. B. L. Crawford:

Specimen consists of a nodular mass of soft, yellowish-red tissue, measuring 1¼ cm. in diameter. On section the tissue cuts with resistance; the cut surface is gray and homogeneous.

Formalin fixation.

Routine technic.

Histology: The small mass of tissue is partially covered by a glandular mucosa resting upon a fibrous tissue base. There is a rather marked inflammatory reaction on the mucous surface, but there does not seem to be any marked overgrowth of the epithelium.

Diagnosis: Glandular polyp of the ileum.

Comment.—It is possible that this patient's abdominal symptoms which she had for two years prior to the operation were due to the polyp. Our notes above give symptoms which are strongly suggestive of gallstones. She has not had any similar attacks since the operation. We should have examined the gallbladder before attending to the intussusception. After the escape of the foul fluid it seemed unwise to examine parts or structures not involved. We should have examined the cecal region for evidence of an appendix. The *x*-ray definitely showed a structure which one would recognize as the appendix, although this organ was removed in 1911 by a most able surgeon. (History given by patient, but not verified by surgeon's records.)

Perhaps the most common cause of intestinal obstruction is a band of adhesion in a patient who has had an abdominal operation. This was our preoperative diagnosis.

There are four chief varieties of intussusception:

(1) Ileocolic; (2) ileocecal; (3) colic; (4) ileal. The ileal, in which the small intestine alone is involved, is comparatively infrequent. Polypus and Meckel's diverticulum may be causative factors.

If one finds difficulty in effecting complete reduction of the invaginated bowel due to the marked edema of the encasing

sheath and the inner tube, it can be greatly facilitated by the method of H. P. Brown (Annals of Surgery, 81, 637, 1925). He incises the intussuscipiens with blunt-pointed scissors relieving the constriction, which leaves a longitudinal wound to be closed. Occasionally this fails and a resection must be done.

CLINIC OF DRS. ROBERT H. IVY AND LAWRENCE CURTIS

FROM THE HOSPITAL OF THE GRADUATE SCHOOL OF MEDICINE, UNIVERSITY OF PENNSYLVANIA

COMPLICATED FRACTURES OF THE MANDIBLE

THE means suggested for bringing about reduction and fixation of fractures of the mandible have been many, the most satisfactory being those which indirectly act on the bone fragments by appliances attached to the teeth to hold the latter in their normal relationships. We have demonstrated to our own satisfaction the superiority of wire ligatures and arches over the various forms of interdental splints for the great majority of cases. One great advantage of these methods is that they can be employed by the general surgeon in emergencies without recourse to the dental specialist. The general surgeon may feel that the details of treatment of fractures of the jaws do not concern or interest him. But as long as cases are admitted to his service in the hospital, it is his responsibility to see that they receive proper treatment, either by himself or by someone delegated by him who understands the problem. The haphazard way in which these cases are frequently handled at present is often a cause of permanent crippling of the function of the jaw, unless correction is undertaken by measures requiring many additional months of treatment.

The routine methods of fixation have been described in previous publications,[1, 2] and will be briefly summarized here. They are not original, but have been adapted from those described by Gilmer,[3] Sauer,[4] and others.

The necessary instruments are to be found in any hospital, and consist of a pair of strong hemostatic forceps, a pair of short-

nosed scissors, and a tenaculum or Backhaus towel clamp. It is also advisable to have a pair of dental dressing pliers. The wire used should be of such a size that it will pass freely through the spaces at the necks of the teeth, and flexible, yet possessed of considerable tensile strength. Of all the various kinds of wire that we have tried, and there have been many, 24-gauge soft brass wire has been the most satisfactory. This is obtainable at any dental supply house or at a hardware or 5 and 10 cent store. The other necessary material is several 5-inch lengths of half-round German silver arch wire, 2 mm. in width, also ob-

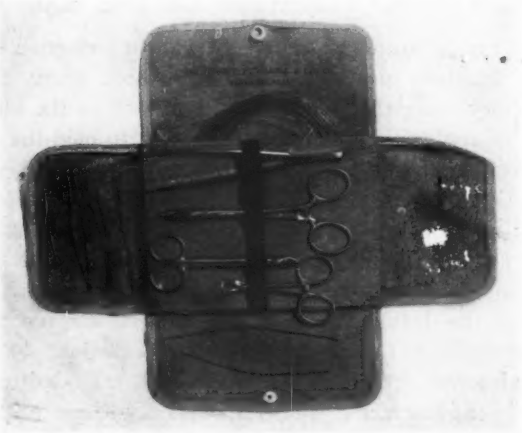

Fig. 575.—Pocket fracture kit containing instruments and materials required for treatment of fractures of mandible.

tainable at dental supply houses. Figure 575 shows a convenient pocket case, containing the instruments and materials required.

Two methods are employed, according to conditions encountered in individual cases.

Method 1.—This is applicable in most of the cases, but requires that there be pairs of adjoining teeth available in several parts of the mouth. It consists, briefly, in fastening 6-inch strands of the brass wire, with an eyelet made at the middle of each strand, around the necks of the premolars on both sides of

upper and lower jaws, the upper central incisors, and the four lower incisors, and joining these three pairs of eyelet wires with three single wires passed through the eyelets and the ends twisted

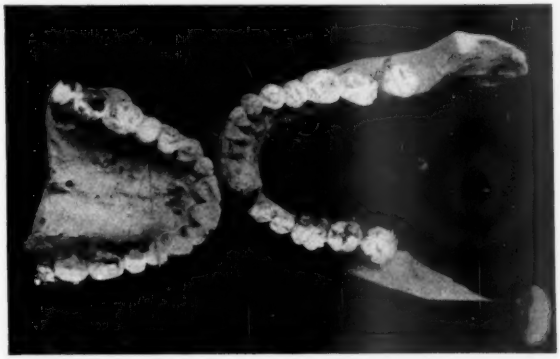

Fig. 576.—Showing method of passing eyelet wires between and around premolar teeth.

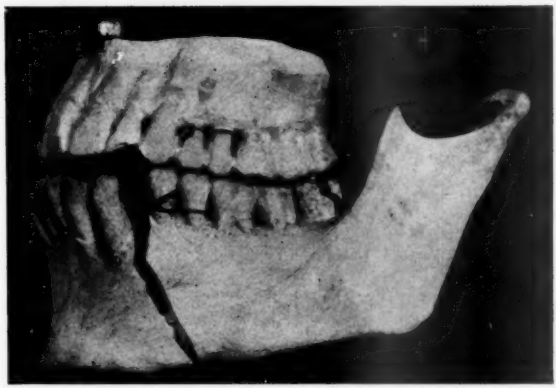

Fig. 577.—Eyelet wires attached to upper and lower premolar teeth. One end of wire is passed through projecting eyelet before twisting ends together, to give more secure fixation.

together after the teeth have been brought into proper occlusion. Details will be best appreciated by referring to the illustrations (Figs. 576–581).

Method 2.—In case the teeth are not sufficient in number and stability for direct application of eyelet wires, we employ the German silver arch wire. This is moulded to conform to the

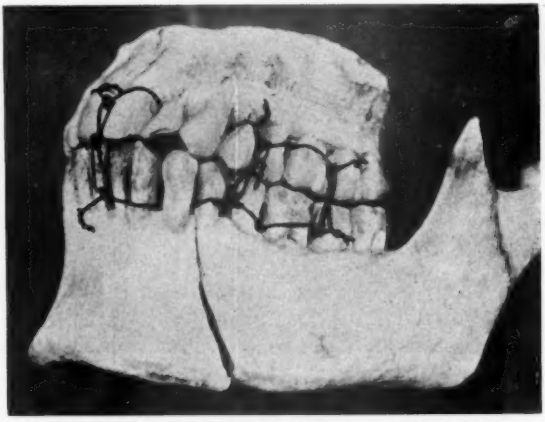

Fig. 578.—Upper and lower pairs of eyelets connected by tie wires, which when tightened reduce fracture and fix teeth in occlusion.

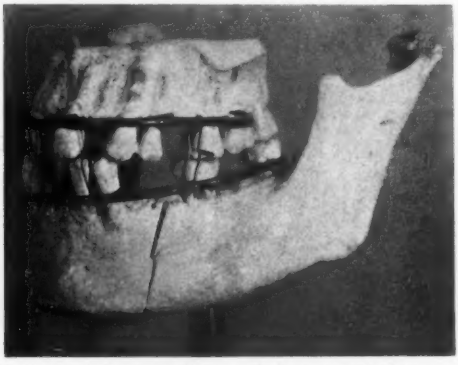

Fig. 579.—Half-round German silver arch bars attached to upper and lower teeth, and connected by tie wires.

vestibular surfaces of the teeth and attached to the latter with brass wire ligatures. A similar arch is applied to the upper teeth and the upper and lower arches are connected by the finer brass

tie wires (Fig. 579). In cases of fracture with considerable displacement, it is often advisable to place a separate half-round arch on the teeth of each mandibular segment, until complete reduction has been obtained. Then, when all of the lower teeth come into occlusion with the upper teeth, the separate arch wires can be replaced by a single arch embracing the teeth of all segments. In cases of marked displacement, gradual reduction can be obtained by elastic traction on individual segments by small rubber bands passed over the ends of the brass wires which fasten the arches to the teeth—these elastics running in the desired

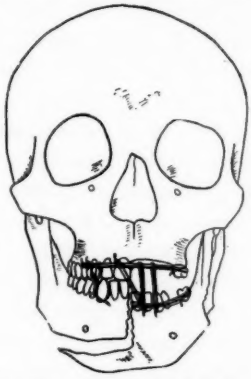

Fig. 580.—Gradual reduction of depressed fragment by rubber bands connecting upper and lower arch bars.

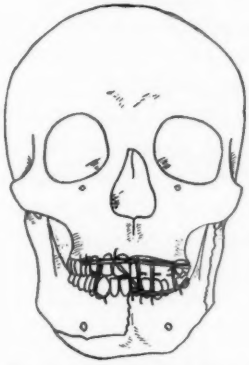

Fig. 581.—Replacement of rubber bands by brass tie wires after reduction.

direction of pull from the lower to the upper arch. When reduction has been completed after a few days by the rubber bands, they can be discarded and the upper and lower teeth fixed in occlusion with brass tie wires (Figs. 580, 581). The arch wire method is more difficult and takes more time to apply than the eyelet method, so we employ the former when the latter is not applicable. In some cases a combination of the two methods is used, the eyelets on one jaw and the arch wire on the other.

At least 90 per cent of all fractures of the mandible, regardless of their location, can be successfully treated by the methods described above. Certain cases occur, however, in which modi-

fications or additions become necessary. Nearly all of these complications are due to absence of teeth from the mandible or from the maxilla. Before taking up these special cases, we wish to consider briefly fractures through the neck of the condyle, which, according to some writers, are to be regarded as complicated cases, but which we do not, as a rule, place in that category. There seems to be a general feeling that when the head of the condyle is displaced at the time of fracture, unless something radical is done to replace the head, dire results such as ankylosis and deformity will follow. Hence, the proposed open operations of Silverman[5] and Aison.[6] That displacement of the head of the condyle is not rare in these fractures is shown by the fact that in 5 cases recently seen the head was drawn forward and inward by the external pterygoid muscle in 3. None of these cases had an open operation, either intraoral or extraoral; none had any special manipulation to put the condyle back in position, and all recovered with good function, without ankylosis or deformity. For several years we have successfully treated all cases, with or without displacement of the head of the condyle, where it has been possible to restore immediately the normal occlusion of the teeth, by the usual method of fastening the upper and lower teeth in occlusion for three to five weeks, and have never seen a case result in ankylosis. Occasionally, where there is considerable shortening of the affected side, with marked deviation of the teeth to that side, it is of advantage to interpose between the upper and lower molar teeth on that side, a piece of base-plate gutta percha or dental impression compound before fastening the teeth together. This will tend to restore the normal length of the jaw on the fractured side. In cases where the teeth cannot be immediately brought into occlusion, gradual reduction by intermaxillary elastic traction will quickly bring about the desired result. It may be safely stated that ankylosis follows injuries to this region only when the fracture involves the joint surfaces, especially in young children, or in compound fractures with suppuration in or about the joint. In the ordinary cases, we regard operative interference as unwarranted and many times harmful.

Among the commonest cases requiring special consideration where the ordinary methods of fixation must be modified are:

1. Fracture in molar or premolar region with long edentulous posterior fragment.

2. Fracture in molar or premolar region with teeth in posterior fragment but no opposing teeth in upper jaw.

3. Fracture of edentulous or almost edentulous mandible.

4. Fracture of mandible with edentulous upper jaw.

5. Comminuted fracture at symphysis with loss of incisor teeth and bone.

1. **Fracture in Molar or Premolar Region with Long Edentulous Posterior Fragment.**—One of the commonest difficulties met with in the treatment of fracture of the mandible is the control of a long edentulous posterior fragment. In a fracture behind the last existing tooth, if this be the second or third molar, the posterior fragment requires no fixation as a rule. If the teeth of the lower jaw are brought in proper occlusion with those of the upper and held there, the short posterior fragment, although it may be slightly out of position, can be disregarded so long as union occurs with good occlusion of the teeth. On the other hand, if the last existing tooth is a first molar or a premolar, and the fracture is just posterior to this, making a long edentulous posterior fragment, the latter will be pulled upward and sometimes inward by the elevator muscles, until the overlying soft tissues meet the occlusal surfaces of the upper molar teeth and there is a concavity in the external contour of the face. If union of the fracture occurs in this position, the normal space between the upper and lower jaws in this region will be obliterated, with attendant difficulties in bringing about a good occlusion with artificial dentures. We have tried the interposition of metal, vulcanite, or other material in the mouth, to keep down the elevated fragment, but this frequently produces marked irritation or even pressure necrosis of the sensitive gum tissue. One of the most satisfactory ways of overcoming this upward and inward displacement is as follows: Through a small skin incision, the angle of the mandible on the fractured side is exposed and a hole drilled through it for the passage of a 24-gauge brass wire.

The wire emerges through the skin wound and is connected by means of a heavy elastic band to a hook on a plaster-of-paris head cap, so placed that sufficient downward and backward traction will be made on the edentulous bone fragment to overcome the upward muscular pull and hold it down and out in satisfactory position. The wire produces no untoward irritation in the soft tissues and may be allowed to remain for several weeks. A very satisfactory and comfortable plaster-of-paris head cap has been described by Scogin.[7] The materials necessary for its construction are:

1. Tubular stockinette, 3 inches by 2 feet.
2. Narrow gauze bandage, 1 foot.
3. Adhesive plaster, 1 inch wide.
4. Orthopedic felt, 4 strips, 1½ by 6 inches.
5. Plaster-of-paris bandages, 2½ inches wide.
6. Traction appliances: Leather straps and buckles, hooks, loops, etc., as indicated. Hooks can very conveniently be made from an ordinary wire coat hanger.

Construction steps (Figs. 582–585):

1. Seat patient in straight backed chair without head rest, and drape with sheet.

Fig. 582.—Construction of plaster-of-paris head cap: Application of first layer of stockinette, and tying with bandage at top of head.

2. Clip hair on men if the case is to require lengthy fixation—otherwise not considered necessary. Have women braid hair and arrange in loose coil on top of head.

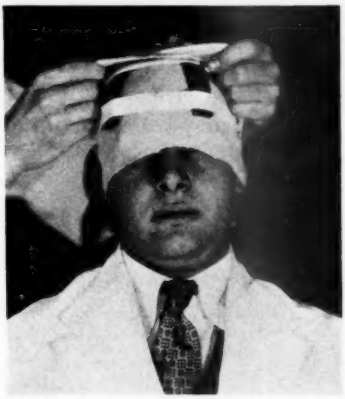

Fig. 583.—Application of strips of orthopedic felt in four quadrants and drawing down of second layer of stockinette leaving felt strips between two layers.

Fig. 584.—Incorporation of traction appliances in plaster of paris bandage.

3. Apply one end of stockinette over head to a point 2 inches below border outline of finished head cap.

4. Tie gauze bandage loosely around stockinette at top of

head, cut slit in stockinette, and push tied ends of bandage through to inside. This is done so that stockinette may be tightened during later treatment if necessary.

5. Cut and adjust felt strips one in each quadrant of head. Fasten in place on stockinette with adhesive plaster.

6. Pull free end of stockinette down over head and trim just short of the first layer. Felt strips are now between layers of stockinette. There is a small opening at top of head in which ends of gauze bandage are found.

7. Apply wet plaster-of-paris bandage over stockinette, smoothing into place.

Fig. 585.—Head cap completed with traction by elastic band and wire through posterior fragment of mandible.

8. Turn up both layers of stockinette to form lower border of cap, plastering smoothly into bandage.

9. Fit traction appliances as indicated for case. These must be so placed as to deliver the correct directional force for the individual case.

10. Apply second plaster bandage, working well around and over traction appliances to hold them firmly in place. The lower $\frac{1}{2}$ inch of stockinette is left exposed to produce a smooth rounded border.

The finished margins of the head cap should extend:

1. Occipital region: Well over the external occipital protuberance.

2. Mastoid region: As close as possible to the ears, but not encroaching upon them.

3. Temporal region: To about the zygomatic arch.

4. Frontal region: Care must be exercised in freeing forehead to about 1 inch above eyebrow line.

In utilizing the head cap for control of the long edentulous posterior fragment of the mandible, a piece of coat hanger wire is embedded in the plaster so that its projecting end, curved backward to form a hook, emerges just posterior to and below the ear. After connecting this with the elastic band to the wire passing through the bone, the larger mandibular fragment is fixed by connecting the lower to the upper teeth with eyelets or arches in the usual manner.

2. **Fracture in Molar or Premolar Region with Teeth in Posterior Fragment, but no Opposing Teeth in Upper Jaw.**—Here the same tendency exists for the posterior teeth to ride up out of position, and it can be treated in exactly the same manner as the previous case.

3. **Fracture of Edentulous or Almost Edentulous Mandible.**—Many cases of fracture of the mandible where no teeth are present require no special fixation other than a head bandage, because exact realignment of fragments is not so important as in cases with teeth present, since minor displacements can be compensated for in the artificial dentures. With marked displacement, however, positive fixation of some kind is desirable. We do not recommend in recent fractures wire sutures through the bone or metallic plates screwed into the bone across the fracture line. Sufficient rigidity is seldom obtained by these methods and infection nearly always occurs. We have found *circumferential wiring*, as first advocated by G. V. Black,[8] to be the most satisfactory means of fixation in the edentulous cases, and it is often very useful in conjunction with intraoral splints or artificial dentures where the teeth are too few or too insecure to afford attachment for wire ligatures. Where circumferential wiring is

to be used, a vulcanite splint is first made like a saddle, to cover the lower alveolar ridge, extending well on each side of the fracture. Or if the patient, as is frequently the case, has an artificial denture, this may serve the purpose of a splint. An incision $\frac{1}{2}$ inch long is made through the skin to the lower border of one of the fragments, and a small curved antrum trocar and cannula are passed up through the incision close to the inner surface of the bone until the mucous membrane of the mouth is pierced. The trocar is then removed, and one end of a 24-gauge brass wire is

Fig. 586.—Fixation of bilateral fracture of almost edentulous mandible by three circumferential wires tied over artificial denture.

threaded through the cannula. The cannula is withdrawn, leaving one end of the wire passing into the mouth on the lingual side of the bone and the other end emerging from the skin incision. The trocar and cannula are then passed downward from the mouth at a corresponding point on the vestibular side of the bone, to emerge at the original skin opening. The other end of the brass wire is then passed up the cannula into the mouth and the cannula withdrawn. The wire now embraces the bone with

its ends projecting into the mouth. The ends of the wire are twisted over the splint or denture so that the bone fragment is drawn up snugly in contact with the splint. Another wire is similarly passed around the other fragment and twisted over the splint (Fig. 586). The circumferential wires are well tolerated, and may be maintained for several weeks, the skin incisions frequently closing without suppuration. In a recent case, we have combined the circumferential wiring with a plaster-of-paris head cap. The patient, completely edentulous in both jaws, had a bilateral fracture of the mandible with falling back of the tongue

Fig. 587.—Holding chin fragment forward in edentulous patient with bilateral fracture by means of circumferential wires attached to head cap.

which interfered with deglutition and respiration. Two circumferential wires were passed around the chin fragment, the ends emerging through the skin incisions and fastened to a heavy wire bar extending downward in front of the face from a plaster head cap (Fig. 587). By this means the chin was held in a forward position, relieving the breathing and swallowing, and allowed union of the fractures in satisfactory position.

4. Fracture of Mandible with Edentulous Upper Jaw.—If the fracture is in the line of the teeth, with little displacement,

a single arch bar embracing the lower teeth usually gives sufficient fixation. But if there is great tendency to displacement, or if the fracture is posterior to the teeth, support must be obtained elsewhere. If the patient has an upper artificial denture, this may be made to serve for attachment of wires from the lower teeth by drilling holes through it. Or circumferential wiring of the fragments may here prove useful. In one case of fracture through the neck of the condyle, with lateral deviation of the jaw, correction was brought about by elastic traction from a plaster head cap on an arch wire fastened to the anterior teeth (Fig. 588).

Fig. 588.—Lateral traction from head cap to correct deviation due to fracture through neck of left condyle. Upper jaw edentulous.

5. **Comminuted Fracture of Symphysis, with Loss of Incisor Teeth.**—These are among the most difficult mandibular fractures to maintain in position. There is a strong pull of the mylohyoid muscles toward the median line, resulting in marked narrowing of the lower jaw so that the gap normally occupied by the incisor teeth is closed and the line of the lower teeth farther back on each side is within that of the upper teeth. If union occurs in this position, the function of mastication by the remaining sound teeth is crippled, and cannot be restored by artificial dentures. This tendency to contracture persists sometimes for several months, and if great vigilance is not observed will resist efforts to overcome it. The ordinary eyelet method of

wiring, even though the remaining upper and lower teeth are good, usually gives insufficient purchase to maintain correct position. If seen early, when the two sides are easily reducible to their full width, fixation by upper and lower arch bars may suffice. But if the tendency to narrowing of the space is noted, additional means of maintaining the full width of the lower jaw must be applied. A satisfactory and simple way of attaining this end is a modification of that of Schellhorn.[9] Separate arch bars are applied to each half of the mandible. The anterior ends of the two bars are left long enough to overlap each other across the gap. Each end is bent to form a hook, and a small rubber

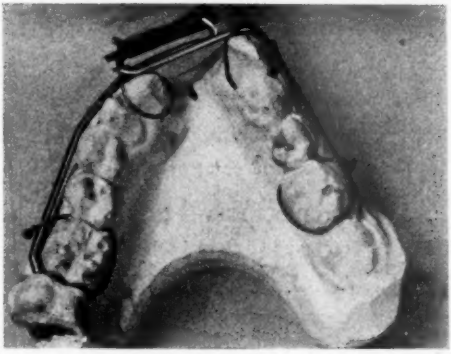

Fig. 589.—Separation of fragments by elastic traction in comminuted fracture of symphysis of mandible.

band around the two hooked ends exerts force on each fragment away from the median line (Figs. 589 and 590). The lower teeth are also connected with the upper by wire ligatures passed around the arches. After full reduction has been obtained, the space can be maintained by fitting a small block of wood between the teeth of each fragment. Fixation must be continued in these cases for at least eight weeks, and frequently longer, until consolidation is complete.

By the application of the principles here described, most of the problems of fixation of fractures of the mandible can be solved. We do not attempt to enlarge upon any other problems arising

in connection with fractures, such as infection, hemorrhage, care of the soft tissues, etc., all of which have to be taken into consideration, but with which the surgeon is more familiar.

Fig. 590.—Appliance in mouth of patient.

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NEUROSURGICAL CLINIC OF DR. TEMPLE FAY

TEMPLE UNIVERSITY HOSPITAL

THE MANAGEMENT OF TUMORS OF THE POSTERIOR FOSSA BY THE TRANSTENTORIAL APPROACH

WITH the perfection of the neurosurgical technic and the improvement in the methods of removing intracranial tumor masses, the greatest problem still entails the adequate control of intracranial pressure.

The successful outcome of the case no longer depends upon the fortuitous removal of a tumor, but directly upon the postoperative treatment and ability to manage disturbances in cerebrospinal fluid pressure. Attention has been directed toward the control and relief of pressure during the preoperative stage of study, as well as its careful regulation throughout the ensuing days following the surgical procedure.

Here we are faced with the mechanics of edema and cerebrospinal fluid obstruction and the solution of the problem lies in the control of these factors.

The postoperative results are largely dependent upon this fact as well. Only too frequently do we find cases where following the successful removal of a tumor or adequate decompression, intracranial pressure continues. Optic atrophy, with blindness, sometimes ensues or herniation of the brain, which not only destroys the remaining cortical tissues, but produces an unsightly and disfiguring appearance. Neurosurgeons are familiar with the fact that certain types of tumors are not only easily removed, but are followed by satisfactory adjustments of intracranial pressure. The situation and the size of the tumor may frequently determine the question of postoperative recovery and the reestablishment of normal intracranial pressure. It is necessary to have in mind the details of the cerebrospinal

fluid circulation and the pathways of this fluid from its origin to its points of elimination, in order to satisfactorily adjust the operative procedure in respect to the final intracranial phenomena.

Cerebrospinal fluid is elaborated for the most part by the choroid plexus of the third and fourth ventricles. A certain amount of the fluid passes in and out of the capillary network throughout the nervous system. The ebb and flow of this fluid has much to do with the actual edema, but is only a part of the volume of fluid produced per day, represented by these highly vascular membranes which dialyze blood plasma into the subarachnoid spaces.

The fluid formed within the ventricles finds an outlet into the cisterna magna and the cisterna pontis in the posterior fossa. The field of absorption is at the present time greatly disputed.

The work of Weed indicates that the major portion of this subarachnoid fluid finds its escape into the large dural sinus by means of the pacchionian bodies. Winkelman's observations would confirm the close association between the pathology of these structures and definite clinical groups associated with increased collections of fluid due to obstruction of these pacchionian outlets. On the other hand, Dandy holds the view of absorption into the large cortical veins, while Hassin emphasizes the pathways of escape through the perivascular and perineural spaces, especially along the cranial and spinal nerve trunks.

It is probable that all of these mechanisms play a part in the elimination of cerebrospinal fluid, and certain it is that its return into the venous system must be accomplished by a method of filtration whether through the pacchionian bodies and subarachnoid villi, cortical veins, or perivascular and perineural spaces. In all probability Weed's and Hassin's views are complementary mechanisms of this system. A certain proportion of fluid leaves gradually by the physiologic permeability of capillary membranes and venous channels. Compensatory mechanisms exist in which the subarachnoid villi play an important rôle in the care of increases in fluid accumulations and rapid elimination when pressure and volume changes require compensation within the "closed" confines of the skull.

The recent observations by means of encephalography seem to bear out Weed's point of view that the large dural sinuses, especially the longitudinal sinus in the region of the vertex, is a most important structure from the standpoint of cerebrospinal fluid elimination, and therefore the pathways for fluid, which permit its progress from the posterior fossa to the vertex over the frontoparietal areas of the brain become of vital interest from the standpoint of the neurosurgical solution of intracranial pressure, when tumors or lesions obstruct the progress of the fluid to its important points of elimination.

Tumors of the posterior fossa, especially those of the cerebellopontile angle, obstruct the pathway for fluid in two ways, either directly or indirectly. The aqueduct of Sylvius and the outlets of the fourth ventricle are sometimes obliterated by compression, or the lesion situated in the cerebellopontile angle may close the cisterna pontis on one side and displace the pons against the edge of the incisura of the tentorium thus obstructing the opposite pathway.

In order that fluid from the posterior fossa may reach the middle fossa on its way to the vertex it must pass through the narrow cisterna pontis. The tentorium divides the middle from the posterior fossa in such a way that only a small space is present anteriorly and on the lateral aspects of the pons to permit subarachnoid fluid to reach the cisterna chiasmatis above. No fluid passes normally over the posterior surfaces of the cerebellum. Hence comparatively small tumors in the cerebellopontile angle may produce a serious block of the fluid pathways, and are associated with rapid rise in intracranial pressure, choked disks and hydrocephalic changes confined to the lateral third and fourth ventricles. The pressure phenomena may not arise until the tumor has reached sufficient size to interrupt physiologic continuity between the posterior fossa and the middle fossa. Clinically, we find rapid swelling of the disk and uniform dilatation of the ventricles with such a lesion. A similar picture is presented by cerebellar tumors, abscesses, and tumors of the fourth ventricle, which obstruct the aqueduct of Sylvius and the foramina of Magendie and Luschka, excepting that the block

is twofold: direct obstruction of the fourth ventricle and its outlets, as well as the aqueduct itself.

The removal of a tumor of the cerebellopontile angle or even of the cerebellum is not always associated with a relief of pressure because of the failure to reestablish the fluid pathways to the middle fossa and the vertex. This is primarily due to the fact that the incisura produces a strangulation effect in the region of the pons, and the fluid pathways once obliterated may find difficulty in readjustment.

Operative procedures upon the cerebellum and cerebellopontile angle have been confined for the most part to the midline suboccipital approach. Here the occipital bone is removed and approach to the angle made from the midline, passing beside the medulla, the tumor or lesion dealt with as the indications may require. In spite of the removal of the lesion there frequently follows cerebellar herniation through the dural opening left as a decompression. Continuation of the intracranial pressure and a gradual progressive loss of vision, as well as mentality, due to persisting internal hydrocephalus ensue. Frequent tapping of the ventricles or drainage of cystic collections, which cannot escape even though they reach the posterior fossa or spinal canal, clearly indicates that the pathways and areas devoted to fluid absorption over the cerebral hemispheres are required for its elimination.

The fault lies in the constricting and unyielding tentorial membrane which prevents the spinal fluid from reaching the middle fossa in the presence of distortion and tumor masses, and gives rise to herniation of the cerebellum and the overaccumulation of spinal fluid in the posterior fossa due to back pressure within the ventricles. After the progressive appearance of a cerebellar hernia, the continued pressure, and oncoming blindness, the neurosurgeon is frequently required to do a subtemporal decompression, as well, with little benefit. The patient is left with an unsatisfactory solution of the problem of intracranial pressure, disfiguring and fruitless decompression, as well as almost certain blindness.

In order to overcome the constricting influence of the ten-

torium, Dowman several years ago practiced cutting this structure from the incisura to the lateral sinus, thereby releasing the cerebellar and posterior fossa and allowing a wide adjustment of brain structure with decompression into the middle fossa, where the posterior approach had failed to adequately deal with the lesion.

When this method was followed by a subtemporal decompression cerebellar herniation was checked.

Naffziger devised an approach through the tentorium to reach the cerebellopontile angle lesions. This gave a method of approach from the upper aspect and at the same time decompressed the posterior fossa through the tentorium.

In this clinic we have attempted to combine the two procedures in one, namely, the former posterior fossa approach for cerebellar and cerebellopontile angle tumors, and the tentorial approach of Naffziger, in order to freely open the tentorium from the incisura to the lateral sinus and thus relieve the strangulation existing about the pons, as well as to permit a decompression of the cerebellum.

At the same time the posterior fossa is exposed by this method and a direct approach to the angle can be made from the most advantageous position. A tumor of the cerebellopontile angle can be dealt with by this method in a most satisfactory manner, because of the larger exposure which is permitted from above and below, the possibility of elevation and rotation of the cerebellar hemisphere after the tentorium has been incised, and the facility with which the lateral sinus may be ligated to permit a complete exposure of the entire cerebellar hemisphere when necessary.

It is possible by this method to advance as far as the posterior clinoid process, to explore both the middle and posterior fossae on the side of operation, as well as the pineal region and the vermis of the cerebellum. The reactions following this procedure with or without ligation of the lateral sinus have been less in my opinion than those of the midline suboccipital approach, and the postoperative results in cases where the suboccipital approach had failed, highly satisfactory.

In 2 cases reported in this series another neurosurgeon had attempted to reach the cerebellopontile angle tumors from the suboccipital approach and had found it impossible adequately to deal with the lesions or satisfactorily to relieve the intracranial pressure present, even though a liberal suboccipital decompression was allowed. Cases I and II in this series clearly indicate the advantage of the transtentorial approach in that not only was the tumor satisfactorily removed in each case, but with the division of the incisura and tentorium, a readjustment of the cerebrospinal fluid pathways and pressure promptly resulted. The reaction in both of these cases, even though in a critical state from the former operative procedure, clearly indicates the advantages of the transtentorial approach.

In the 5 cases presented, 2 were cerebellopontile angle tumors, 1, metastatic carcinoma involving the cerebellum and cerebellopontile angle, 1, an hemangioma of the angle, and 1 a case with midline fourth ventricle tumor that died on the eighth day due to a secondary hemorrhage of the pons following a fall from his bed.

One case was operated upon twice, the first stage clearly exposing a tumor that had proved "inoperable" two years previously. The vascularity of the lesion and its deep extension under the pons did not permit its removal on the first attempt. Seven days later the postoperative recovery was so satisfactory that reexploration was undertaken, the tumor removed, and its angiomatous capsule ligated. The tumor involved the vagus roots, pons, trigeminal roots, and the sigmoid sinus. The patient developed hyperthermia and vasomotor failure seven hours after operation, probably due to disturbance of pontile circulation. Respiratory rate and pulse rate remained undisturbed to the last without signs of medullary failure. Temperature rose to 107.5 F. and no blood pressure could be obtained for two hours prior to death—transfusion, infusion, pituitrin, adrenalin, glucose, digalen, and strychnin failed to bring forth any detectable blood pressure sounds. In my experience, lesions of the pons and subthalamic region give rise to hyperthermia and vasomotor failure, which fail to respond to any means now at our

disposal. It will be noted that the two deaths in this series suffered pontile injury and both were considered "inoperable."

Of the entire group, 3 cases had been operated before coming under my charge, and had been pronounced "inoperable." Of these, 2 have survived after removal of the tumor. The method of approach made possible the removal of a closely adherent carcinoma of the angle; the subcortical midline tumor was considered inoperable from any method.

Operative Technic.—An incision is made 1 cm. from the midline and parallel to the midline from a distance of approximately 8 cm. above the occipital protuberance carried well down into the neck to the level of the second cervical spinous process (Figs. 591–595).

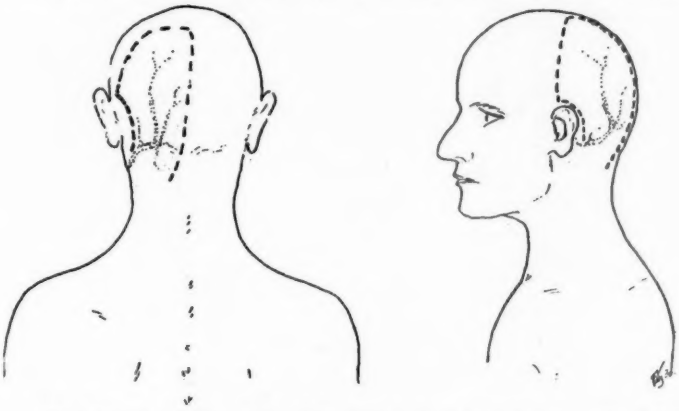


Fig. 591.—Scalp flap designed for transtentorial craniotomy. Note the inclusion of the occipital artery and its branches, with extension into the muscles of the neck.

A right angle incision is carried from the upper angle of the wound to the level of the base of the ear, anterior to the mastoid, thence posteriorly along the mastoid eminence to the tip of the mastoid. Care should be taken to include the occipital artery and posterior auricular artery in this flap. Trephine openings are made so as to define a bone flap similar in shape to the one outlined for the scalp. Here it is important to make one trephine opening just below the occipital ridge and 2 cm. from the midline.

The next opening is made approximately 5 cm. above and over the occipital pole. This opening may be used for tapping the ventricle. The third trephine should be made approximately 3 cm. from the midline at the upper angle of the wound.

A temporoparietal trephine opening is then made on the lateral surface of the skull and another as far down toward the base as can be accomplished, which should place it just above the attachment of the ear. The final trephine opening is made just behind and slightly above the mastoid, care being taken to displace the occipital artery and the muscle attachments.

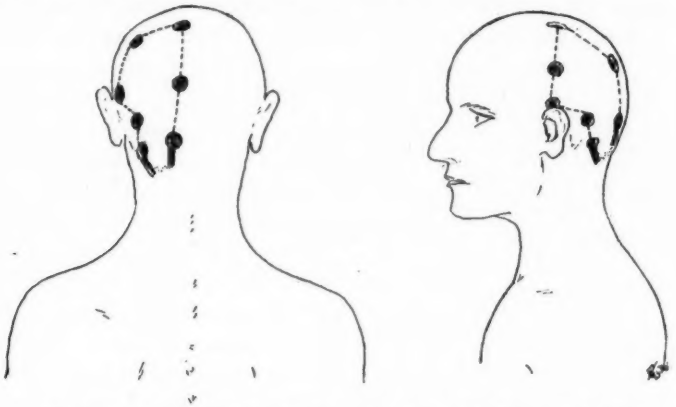


Fig. 592.—Location of trephine openings in the skull required to expose both the temporo-occipital lobe and the cerebellar fossa. Note extension by DeVilbiss at the base of the bone flap, so as to include the posterior fossa.

Care should be taken in making this last trephine opening because frequently the emissary vein of the mastoid is encountered. This is quite often large and associated with free bleeding. It is easily controlled by bone wax or muscle graft and because of this possibility the trephine at this point is left until the last.

The flap is carefully sawed and beveled with a Gigli saw. The only difficulty that is present in this procedure is the division of the bone at the base over the region of the mastoid. This should be carefully accomplished as the lateral sinus lies below.

The thin occipital bone is then cut down toward the base by means of the DeVilbiss and the flap broken as close to the foramen magnum as possible. The bone flap and neck muscles are easily retracted so as to give an ample exposure of the occipital pole and cerebellum. The opening may be enlarged by ronguer as needed. The dural flap over the occipital pole is then incised and turned down. Here the temporo-occipital lobe will be found at-

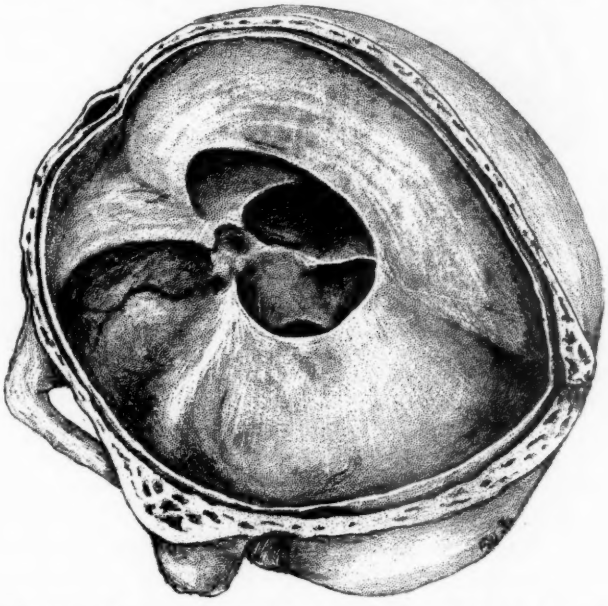


Fig. 593.—View of the left superior surface of the tentorium from above and behind, showing the relationship of the falx and the constricting incisural ring; section of the tentorial surface from the incisura to the lateral sinus and thence posterior to the torcular Herophili giving a decompressed tentorial division between the middle and posterior fossa, as well as direct exposure of the superior surface of the cerebellum and the cerebellopontile angle.

tached to the lateral sinus by two or three large veins. These must be carefully ligated and divided. Immediate access is possible by elevation of the occipital lobe to the superior surface of the tentorium, the middle fossa, and the upper surfaces of the

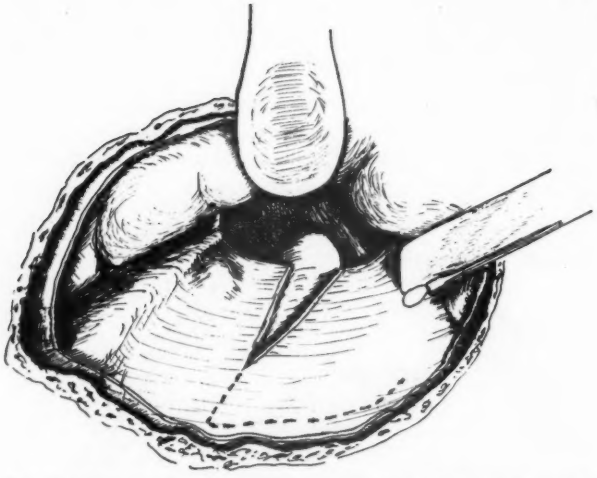


Fig. 594.—Case I. Exposure of the dorsal lateral cyst and tumor of the cerebellopontile angle showing section of the incisura and tentorium after elevation of the occipital lobe. The decompression of the crus, as well as the posterior fossa, is an important objective in this operation. Adequate exposure of the cerebellopontile angle is also obtained.

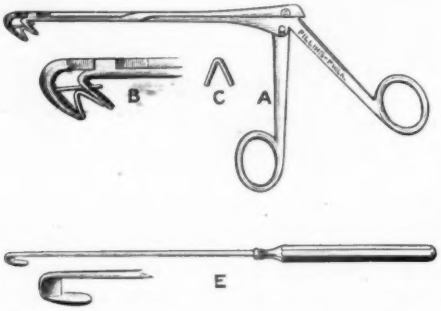


Fig. 595.—Instruments designed to section the tentorium from within out. The silver clip holder (A, B, C) is designed so as to place the clip on each edge of the incisura before inserting the protected knife blade (E) between the clips, permitting section of the tentorium by drawing the knife toward the operator and at the same time protecting the upper surface of the cerebellum. The instruments have been perfected through the assistance of George P. Pilling & Son Company, Philadelphia.

petrosal bone. As the ventricle on the side of the operation has been evacuated, the occipital lobe is elevated and by means of retractors a clear view of the upper surface of the tentorium is obtained. By the use of silver clips, the marginal vein of the incisural opening of the tentorium is secured and the lip of the tentorium cut, the tentorium incised outward to the lateral sinus and the margins reflected.

Care must be taken not to dislodge a large cerebellar vein which empties into the petrosal sinus near the attachment to the posterior clinoid process. Sufficient distance from the sigmoid sinus must be maintained so that this sinus is not injured in carrying the opening toward the base. The tentorial surface is then folded over, giving immediate access to the superior surface of the cerebellum and cerebellopontile angle.

The dura covering the inferior surface of the cerebellum is then opened by means of a horseshoe flap under the lateral sinus and the posterior fossa exposed, the lateral sinus separating the two fields of operation. The sinus may be ligated giving free access to the cerebellum, or by means of a brain retractor the cerebellum elevated from the posterior fossa through the tentorial opening giving free access to the cerebellopontile angle from either above or below, and the immediate disclosure of a lesion in this position.

If a decompression is desired, one has by means of this exposure, free access between the posterior fossa and the middle fossa (temporo-occipital area). With the tentorium divided and the removal of the bone flap, if necessary, an extensive and adequate decompression is given, thus combining three procedures in one.

The technical difficulties in this operation are undoubtedly greater than either of the former methods, but the results obtained justify the time in the ligation of the venous channels encountered, and the favorable postoperative reactions make this method superior to the former posterior fossa approach, where lesions are deeply placed or extend to the superior lateral surface of the pons.

The objective gained is not only an adequate view of the le-

sion, but a most satisfactory decompression from all aspects, should the lesion prove to be inoperable or of a recurrent type.

CASE REPORTS

Case I.—J. McC., male, aged twenty-five years, admitted to the Temple University Hospital, September, 1929.

Past Medical History.—Was admitted to the Temple University Hospital in June, 1929, with a complaint of headache, pain in left eye, swelling of gums on the left side, which has been present for two years, having started then with headache on the left side of the head from midline anteriorly to temporal region on line of external auditory meatus. Pain in eye started about two months before admission. Pain and swelling in the mouth about two weeks before admission. With this came sharp pain in the left ear and the patient began to lose hearing in his left ear. Patient had been vomiting once or twice daily for six weeks before admission in June. After study in Temple University Hospital, it was felt that there was definite evidence of a brain tumor involving the cerebellopontile angle, and the patient was transferred to Dr. Babcock's service.

Operative Notes (7/15/29—Dr. W. W. Babcock).—Cushing's cross-brow incision. Foramen magnum opened. Stellate division of the dura, disclosing a thin-walled cyst lying anteriorly to the nerve trunks which was found in left cerebellopontile angle. The cyst was opened and evacuated. About 15 cc. of thin brownish-red fluid was obtained. Cyst walls ½ cm. thick. Owing to the nerve connections only a minute portion of the cyst wall was removed, leaving an opening into the cyst of 5 mm. in diameter. The dura was not closed. The muscle was partially closed. The bone was not replaced. The patient progressed sufficiently well so that on 8/6/29 (one month before present admission) he was permitted to leave the hospital and was to be kept under observation by the eye clinic.

Present Illness (9/12/29).—The chief complaints are vomiting and weakness. Began three weeks ago or about one week after leaving the hospital. There has been increasing weakness and vomiting of projectile type. Attacks have increased from one every three or four days to several a day. Patient now has dull left-sided temporal headaches and anesthesia of the left half of the tongue and inside of the cheek.

Physical Findings.—Head: There is some drooping of the left side of the face and the jaw is somewhat turned to the right. Eyes: There is lateral nystagmus present when the eyes are turned to right or left. Anesthesia of the left side of the tongue. Heart, lungs, and abdomen are grossly negative. Extremities: The Achilles reflexes are exaggerated. There is a Babinski on the right, but none on the left.

Neurological Examination (9/13/29—Dr. Silverstein).—Patient complains of pain in suboccipital region, left side of the face, below the left eyebrow, including the left side of teeth and left side of tongue and cheeks. Palpebral fissure is narrower and the pupil of left eye is smaller than the right. Recession of left eyeball, compared to that of the right (Horner's syndrome). Both pupils react to light promptly. The left is more contracted.

There is a lateral vertical nystagmus. Ocular movements are well performed. Patient can wrinkle forehead. There is corneal anesthesia of the left side. Some hypesthesia on the left side of the face as compared to the right on course of third division of the fifth nerve. No involvement of masseters. There seems to be involvement of posterior third of the tongue. The tongue shows no atrophy and is not deviated in the floor of the mouth. There is coarse tremor of the tongue present. Eighth nerve involvement present. Olfactory sense was not satisfactorily tested because of rhinitis. There is no apparent paralysis of the soft palate. The finger-to-nose test is done with a suggestion of tremor, fairly well performed with the left hand. Finger-to-finger test is done with semi-incoordination. There is no adiadokokinesis. The reflexes in the upper extremities are very active on both sides. There is no Hoffmann's sign. The abdominal reflexes cannot be obtained. Heel-to-knee test shows marked asynergia on both sides. Both Achilles reflexes are prompt. There is a positive Babinski on the right side, none is obtained on the left. Rebound phenomena cannot be tested due to the condition of the patient. Fifth, sixth, eighth, ninth, and tenth nerves involved with marked cerebellar signs and right hemiparesis. Patient's neurological condition at the present time is as marked as prior to his operation.

Eye Report (9/16/29—Dr. Gouterman).—Palpebral fissure of right eye is suggestively narrower than that of the left one, as a result of a slight paresis of the upper lid. Anterior and external segments, except for corneal anesthesia, are negative. Pupils round, 4.5 mm., react to light and in accommodation and consensually. Muscle movement limited to the extreme left. Nystagmic movements are present in the extreme fields of rotation. Tension is normal. Fundus: Media is clear. Disk details and margins are hazy. Level 2.5 diopter of elevation in right, and 3.0 diopter in the left. Veins engorged, arteries are smaller than normal. Vessels are tortuous. Macula is negative. Impression: Corneal anesthesia, slight ptosis of upper right lid, paresis of left external rectus muscle. Early papilledema.

Neurological Examination (9/16/29—Dr. Winkelman).—The patient has a fifth, sixth, and eighth nerve involvement on the left side, hypesthesia on the left side of the face. Right labiofacial fold on the right side less marked. Pulls the corner of the right side of the mouth less than the left. Right biceps more active than the left. Right knee jerk is also slightly more active. Positive Babinski sign on the right. Patient complains of pain in the sensory distribution of the fifth nerve on the left side associated with corneal anesthesia. The patient probably has a refilling of the cyst with extension of the lesion forward and anteriorly involving the fifth, and also giving pyramidal tract signs due to pressure.

Operation (9/19/29—Dr. Temple Fay).—Parieto-occipital craniectomy—left transtentorial approach for angle tumor. Rectal anesthesia. Because the patient derived no benefit from the suboccipital decompression formerly undertaken, it was felt that the need for a decompression of the middle fossa would be required and an attempt to section the tentorium so as to permit release of pressure from the upper pons. Dr. Winkelman located the lesion as being high, and probably near the incisura A subtemporal decompression was made on the left and full exposure obtained at the left temporal lobe.

Dura was then opened and the temporal lobe elevated. One of the large venous sinuses emptying into the lateral sinus was ligated. The left ventricle was tapped and fluid obtained under pressure. The hemisphere was then elevated and the tentorial surface was easily seen. At the apex of the tentorial surface a bulging mass was seen, the size of an olive, beneath the tentorium. An incision was made through the tentorium and the tumor thus encountered, which was soft and gelatinous, and some of the mass removed by curet and much of it by suction.

The petrosal sinus was opened and bleeding was quite marked, but easily controlled by muscle graft. After removal of the tumor mass it was noted that there was a large cyst under the tentorium and closely proximating the crus and upper pons. This cyst was opened and evacuated. The cyst wall was cut away. It was at this point that the incisura was sectioned and terrific bleeding encountered from a large vessel, probably the main petrosal vein. Bleeding was extremely profuse and boiled up in the wound in large quantities. It was immediately controlled by direct pressure from the finger, and a muscle graft, so that bleeding was completely controlled. By means of the electric cautery it was possible to section the tentorium so that the objects of the operation were entirely accomplished and the tumor removed. The cyst was evacuated and also the tentorium sectioned by this approach. It was evident that although the technical difficulties are greater, the value of this approach in certain cases is to be considered superior to the usual posterior fossa approach. Closure of the dura was made leaving a crucial incision for decompression. Closure of skin with silkworm and gut. The time required for operation was six and one half hours. The patient was returned to the ward in good condition.

Neuropathologic Report.—Microscopical description: The small pieces of tissue gotten for study show a very loose structure with numerous small spaces and with numerous small nuclei that at first glance resembles glial processes or fibrils. These cells are, therefore, mesodermal. Small and large cysts are to be seen with most of the tissue forming the smooth lining of the wall of a large cyst. No nerve fibrils are to be seen.

Microscopical Diagnosis.—Perineural fibroblastoma (Dr. N. W. Winkelman).

Neurosurgical Examination (9/30/29—Dr. Temple Fay).—The patient is word deaf, but not word blind. There is weakness of the right side of the face. The disturbance of association of words is distinctly jargon in type. There is no Hoffmann's sign. Reflexes (biceps) are increased slightly on the right. Patellar reflexes are prompt and slightly increased. There is no clonus and no Babinski.

Neurological Examination (10/3/29—Dr. Silverstein).—The patient seems to be markedly improved mentally. Lies in bed apparently reading a paper. Complains of some discomfort in the right face, although does not allude to pain in the left side. There is still definite weakness of the lower right side of the face. Reflexes in the upper extremities are very brisk bilaterally with no Hoffmann's sign. The grip in the right hand seems less than the left. Patellar reflexes are prompt. Aphasic symptoms are much less marked. There is less difficulty in expressing words and making himself

understood. Word blindness is less marked. Patient can distinguish letters, but he has definite disturbance in forming words. Word deafness is only apparent when complicated questions are asked.

Impression: In general there is very marked mental and neurological improvement since the first study of the patient's condition.

Eye Examination (10/4/29—Dr. Gouterman).—There is slight limitation of muscle movement to extreme left, but no diplopia. Fundus shows a very blurred disk (O. S.). Fine capillaries on disks are visible. Level 1 D. of swelling. Vessels 2 : 3. Veins are tortuous, more so than the arteries. No hemorrhages nor exudates are seen in the periphery or in the macula. (O. D.) Fundus—disk is hazy. Upper nasal segment is definitely pale, suggesting early atrophic changes. Otherwise like its fellow.

Neurosurgical Examination (10/10/29—Dr. Nicholas Gotten).—The patient is oriented. His aphasia is greatly improved, and he can read newspapers with only an occasional mistake. He continues to complain of pain in his face, which is hypesthetic. He also complains of pain in his tongue. Station and gait are about normal. There is no vomiting. Temperature, pulse, and respiration are normal and have been for the past ten days. He does not complain of headache. Wound is well healed and clean. There is a small pressure sore over the left occipital region. Patient ready for transfer back to neurological service.

Neurological Examination (10/10/29—Dr. N. W. Winkelman).—No Horner's syndrome today. Deviation of jaw to left. Still weakness of motor fifth. Lower right face is still weak. Reflexes of the right upper extremities much increased. There is a Hoffmann's sign on the right, much less on the left. No Babinski; no Rossalimo, no clonus. The right Achilles are more exaggerated than the left. Left external rectus is still weak. Associative lateral movements normal.

Eye Examination (10/16/29—Dr. Gouterman).—Patient complains of occasional diplopia to the extreme left. On examination muscular rotations and convergence are full. Nystagmoid rotary movements present in extreme fields of rotation. Palpebral fissure is still smaller (O. S.) than that of O. D. Eyeball does not appear enophthalmic. Pupil is smaller than that of O. D., about 1 mm. less. Fundus is more clear. Disk, oval, hazy throughout, showing 1 to 1.5 D. of elevation. Color of a uniform muddy gray. Vessels are still tortuous and overfull. Macula and periphery are negative—O. S. O. D., media clear. Disk oval. Details quite distinct. Hardly any elevation. Otherwise like its fellow. Impression: There is a decided improvement in the patient's eyes. Swelling of the disks is definitely subsiding with improvement in vision.

Case II.—Mrs. C. MacN., female, twenty-five years of age, admitted to the service of Dr. N. W. Winkelman, Temple University Hospital, February 23, 1930.

Past Medical History.—Was admitted to the service of Dr. F. C. Grant, November, 1927, Polyclinic Hospital. An abstract of the notes and operation follows.

Chief Complaint.—Onset, October 9, 1926, more or less sudden. Patient

gave up work and then had abscessed throat. Vomited occasionally, not regularly, especially when nervous or excited. Always high strung. Patient claims that one year (1925) she had a "nervous breakdown." Was not in bed, but was "done out." Sleeps all day long, could not be awakened. Saw double at that time, blurring at first. In April went to bed for one week. Slept all the time. Gets drowsy now.

Physical Examination (11/1/27).—Nystagmus is marked. Weakness is present in the left external rectus. There is left facial palsy (began twelve years ago; improved until one year ago and then left side of the face began to twitch and became worse. Was hardly noticeable up to one year ago). There is a slight defect in hearing of the left ear. There is definite decrease in sensation (pain) of the left face.

Progression Notes (2/22/28).—Practically no change, feels sleepy all the time. Fell twice in the street. Staggers in walking to the right. Hemiparetic on the left side. Has lost 7 pounds in the past five to six months. (Has attempted suicide.) There is a lump over the left occipital region. Weakness of the motor fifth involved. There is coarse nystagmus; left peripheral facial palsy. Eighth nerve: cochlear left decreased; fifth nerve less sensitive; corneal hypesthesia. The tongue goes to the right. The uvula is normal. There is a slight speech defect. Adiadokokinesis is present on the left. The knee jerks are exaggerated on the right, flabby on the left. Muscle position and vibration are normal. There is no Babinski. The left Achilles is absent, the right is present and normal. There is hyperesthesia on the left side. In the heel-to-knee test the left side is incoordinate. There is mild hypesthesia on the right. Menses regular. Has urgency, cannot hold urine well. 7/30/28: There has been projectile vomiting and afterward headaches. Vomits only with excitement, dizzy on walking. Patient can do things with the right hand and is getting more control of the left. "Wabbles" on walking. Has improved in the last six to eight months. Tends to hold the head toward the right. Pupils are small, equal, regular, and react quickly (on reaction of L. rotary movement). There is bilateral nystagmus combined with a rotary movement of the left eye toward the nose. On looking to the right, quick component to right; on looking to the left, quick component to the left. Diplopia is marked to the left, much less so to the right. On looking up, eyes have a rotary nystagmus, on looking down the nystagmus stops. The tongue deviates to the right. There is complete left facial palsy. There is a Holme's rebound phenomena on the left. Adiadokokinesis is present on the left. With the arms outstretched on pronation and supination, the left hand goes lower.

Special Reports (10/27/16).—Bárány report (Dr. Myron A. Zacks): Vestibular findings: (1) Evidence of a central lesion. (2) Evidence of increased intracranial pressure. (3) Cochlear portion of both eighth nerves functioning well. (4) On turning, the nystagmus, vertigo and past pointing of the horizontal canal on each side are markedly diminished. (5) On douching with cold water the right vertical responds well. The right horizontal, however, shows perverted responses. On douching the left ear with cold water, the left verticals do not respond. The left horizontal shows fair, but perverted responses. Conclusion: (1) The case acts like a posterior fossa

involvement. (2) Both cerebellopontile angles can be definitely excluded. (3) The findings favor a lesion either, first, cerebellar, left-sided, high up, or second, a lesion in the pons, left sided.

Eye Examination (7/5/28—Dr. Louis Lehrfeld).—The left palpebral fissure is widely open as compared to the right, which is normal. On closure of the eyelids the left eye responds only partially, indicating a paralysis of the seventh nerve. On fixation there is noted a rotary nystagmus combined with an horizontal nystagmus, which is exaggerated on upward deviation of the eyes. The pupils are round, equal, and react sluggishly to light. There is a partial palsy of the left external rectus causing diplopia in the right field. The right fundus—the edges of the disk are completely obliterated and there are edema and swelling at the superior nasal quadrant. The vessels are somewhat tortuous. At the inferior nasal quadrant, just off the disk, is a fine retinal hemorrhage. The left disk is also blurred in its outline and there is a distinct swelling at the superior temporal quadrant and extensive hemorrhage on and adjacent to the temporal and nasal side of the disk. While the disks are not extremely choked, I am inclined to regard them in the early stage of choking and more advanced in the left eye. It is impossible to take fields of vision because of the weakness of the patient. My records of November 1, 1927, show the same external findings, but there was no evidence of fundus involvement.

Spinal Fluid Examination (8/2/28): Fluid under 12 mm. mercury pressure. Clear. Fehling's solution reduced, six cells. Wassermann negative.

Operative Notes (8/14/28—Dr. Francis C. Grant).—"Suboccipital craniectomy. Local anesthesia reinforced by oral ether. No tumor found.

"*Comment.*—This patient seemed to give evidence of a left-sided cerebellar tumor. I was not sure that it was an angle tumor, because no tinnitus was present. However, she did have involvement of her left fifth, sixth, seventh, and eighth nerves, together with cerebellar symptoms. The only unexpected finding was a low spinal fluid pressure, although to counteract this, choked disks of 4 diopters had been reported.

"*Operation.*—The patient was given her chloratone by rectum and 1 grain of codein in two doses about three quarters of an hour apart before operation. We told her that we would carry through the procedure under local anesthesia and she seemed quite willing. The usual infiltration to tap the ventricles was carried through. The cross-bow incision was made. The right ventricle was tapped without difficulty and seemed distended. The cross-bow exposure was then carried through with very little bleeding, and the bone exposed from one mastoid to the other. An especially large bony opening was made, particularly over the left side where the mastoid cell was opened. Up to this time the patient had been very cooperative. We then nicked the dura, opened it, and tied off the occipital sinus. At this point, for some reason or other, the patient commenced to strain; she got her chin down against her neck; she became cyanotic; her cerebellum commenced to bulge. We had then the trouble of getting her head back in the proper position. She then stopped breathing and respiration was not renewed until we had hastily removed the atlas and axis, opened the dura down over the upper cervical cord, and released the cerebellar tonsils from the foramen. There was little

or no fluid in the basilar cistern. We then got the patient under ether and her condition was only fairly satisfactory. However, we were able to explore the left cerebellopontile angle and we could find no evidence of tumor. The left cerebellar hemisphere was needled, but no tumor was found. It should be said, however, the left cerebellar hemisphere looked definitely larger than the right. Inasmuch as we had had this respiratory difficulty, and inasmuch as there was no gross evidence of tumor, it seemed wise to desist from further exploration and close the wound. Unfortunately, our hemostasis was not satisfactory. There seemed to be some bleeding down in the depths of the left cerebellar recess which we could not control because of the bulging of the cerebellum. I hesitated to retract it with much force fearing lest we should rupture its surface and make the bleeding worse. However, the field was fairly dry when we stopped. The muscles were closed as usual in layers with a fascia layer over them, then the galea and the skin. The patient's condition on leaving the table was satisfactory. No transfusion seemed indicated.

"It is a pity that we should have had this respiratory collapse because up to that time our operative procedure had been carried through in a very satisfactory fashion. I am sure that the patient does not have an angle tumor. It seemed to me possible, in view of her respiratory collapse, that she may have an infiltrating pontine growth involving her brain stem and the nerves on its left side. If this be the case, of course, the prognosis is very bad."

Chief Complaint.—On admission to Temple University Hospital, 2/23/30, the only complaint is inability to walk alone or with the aid of a cane for the past three weeks.

Family History (2/24/30).—Father died aged thirty years, typhoid fever; mother aged fifty-nine years, living and well; two brothers and one sister living and well.

Past Medical History.—As far as is known patient was a normal child. Walked and talked at eleven months of age. Breast-fed baby. Had "measles" several times when a child. Had pneumonia twice, but does not remember how long ago. Typhoid fever when two years of age. Claims she was very good in her studies. Finished junior year in high school and then went to business school and finished there.

Menstrual History: Started when patient was thirteen. Regular every twenty-five days, lasts five days. Pain occasionally on first day. Married. No children, miscarriages or abortions. Slightly injured in May, 1929 in automobile accident. Left hip and right knee bruised and also right thigh and knee. Shock of accident made her nervous, although she did not lose consciousness.

Eye Examination (2/24/30).—O. D., 20/30 without glasses, O. S., 20/50. O. D., 20/30 with glasses. O. S., 20/40. Palpebral fissure of O. S. wider than that of the O. D. Patient is unable to close lids. Eyeball prominent. Lids: lower lid shows a slight degree of ectropion. Conjunctiva faintly injected. Sclera, blue. Cornea clear. No anesthesia. Anterior chamber normal. Pupils are round, 4 mm. React to light, accommodation, and consensually. Muscle movements full. Convergence slightly limited. Nystagmus, horizontal, present in all the fields of rotation. Rapid to the right and slow to the left. O. D. like its fellow except for no paralysis of lids

Media clear. Disk vertically oval. Details and margins obscured, merging with the surrounding peripapilledema. There are a few linear fine hemorrhages. O. S. below the disk, in the horizontal plane about one disk diameter below the disk margin. Disk is swollen about 3.5 D. Vessels ratio, 1:2; veins are overfull, while the arteries are smaller than normal. There are arteriovenous crossings without compression. Light reflexes are slightly increased. No hemorrhages are seen in the rest of the retina. Unable to get a view of the macula through the undilated pupils because of the coarse nystagmus. O. D. like its fellow except for a disk which shows a low-grade papillitis without choking and smaller vessels, especially the arteries.

Summary and Impression: Wider left palpebral fissure as a result of a paralysis of the seventh. Slight ectropion of the lower lid. Slight convergence insufficiency. Choked disk O. S. Low-grade papillitis in O. D. Angiofibrosis. Would recommend temporary suturing of the left lid in order to prevent a keratitis with lagophthalmos.

Nose and Throat Examination (2/24/30).—Nose: right-sided high deviation of septum. Apparently no sinus infection. Throat negative.

Examination of Eyes (3/3/30).—Fail to find limitation of movement of the external rectus, nor corneal anesthesia in the left eye. There is no paretic strabismus nor secondary deviations, suggestive of left external rectus. On turning to the right, eyeballs show a coarse nystagmus, consisting of a rapid and slow component, while to the left there is a slow nystagmus. Fundus: swelling on the left disk is 3 D. at this time, instead of 3.5 D. as originally.

Supplementary Report (Dr. L. C. Peter).—The above report of Dr. Gouterman confirmed in all respects, except in the elvation of the disk which I find a little lower 1.5 to 2 D. Both nerve heads are exceedingly pale and undergoing atrophic changes. I also find a weakness in external rotation of the left eye. There is, however, no diplopia.

Physical Examination (2/26/30—Dr. Oliensis).—Chest is long and phthisical. Moderate dulness at the right apex. No râles, otherwise clear. Heart area is normal. Heart sound good and regular, no murmurs. Vessels soft and hypotension. Blood pressure 110/75. Abdomen relaxed. Right kidney palpable, but O. K. The liver is not enlarged. The spleen is not palpable. The extremities are negative, no edema. Impression: Medical condition is negative. Good surgical risk. 3/3/30: Patient's condition remains the same, only one additional point. Patient wakes up talking and keeps talking insistently all day long. No sense to her conversation whatsoever. Keeps cracking jokes and asking silly questions. 3/8/30: Witnessed a vomiting spell. Seems to be projectile in character. 3/11/30: Complained of earache on the left side, dating back to previous evening. 3/12/30: While the picture presented by this patient in some respects resembles a disseminated sclerosis, the history of choked disk, visual disturbance, vomiting, and progression of symptoms since first onset, with some relief after operation, especially as to sight, tends to indicate a space-taking lesion, probably an angle tumor (Dr. Clemens).

Special Reports (3/6/30).—Report from the bronchoscopic clinic: Mirror examination shows unimpaired motility of the laryngeal musculature. The coordination is good on phonation and on cough, but there is a slight irregular-

ity and hesitation in the approximation of the cords. When they do reach the midline, however, the approximation and tension are good. The hesitation, when it is apparent, is symmetrical. This cannot be called an abnormality, inasmuch as it is often noticeable in normal individuals.

Bárány Examination (2/25/30—Dr. Winston).—(1) Spontaneous nystagmus when looking up, down, right, and left. (2) Both ears are nonresponsive in their vestibular portions. There is slight impairment in hearing in the left ear. These findings indicate definitely the presence of a brain lesion. Both cerebellopontile angles can be definitely excluded. The cerebellum appears to be uninvolved. I believe we are dealing with a brain stem lesion.

x-Ray Examination (3/4/30).—No evidence of a tumor, but the occipital region shows evidence of a previous operation.

Operation (3/13/30—Dr. Temple Fay).—Transtentorial exploratory craniectomy. Left cerebellopontile tumor removed. An occipital flap was devised so as to approach the temporo-occipital lobe. The patient's condition and her frail, emaciated state did not warrant the time needed for a cosmetic effect. A rapid decompressive craniectomy was therefore done. The bone was removed down to the level of the lateral sinus. The dura was then opened and a flap turned back on the sinus. There was a large vein entering the lateral sinus from the temporosphenoidal lobe. This was ligated with difficulty, but without hemorrhage, and sectioned. The pacchionian body was then encountered over the occipital lobe with a plexus of veins from the cortex, entering the tentorial dura. With three silk ligatures, these vessels and the pacchionian bodies were ligated on each side and division made between the ligatures. This immediately released the occipital pole which was then elevated and the tentorium was noted to be bulging upward; the right ventricle having been tapped, allowed displacement of the cerebrum as the fluid drained away.

The incisura was encountered and found to be adherent to the upper surface of the cerebellum and the crus. These structures were firmly crowded against its edge so that it had cut into the boggy peduncle. By use of a special reversed silver clamp, the tentorium was sectioned from the incisura to the lateral sinus and backward toward the torcula. This permitted easy access into the angle and over the superior surface of the cerebellum. A boggy mass presented, with the appearance of a subcortical cyst in the region of the anterior portion of the cerebellum directly in the cerebellopontile angle above and lateral to the pons. An instrument was introduced into the boggy area and an ounce of fluid escaped, apparently a cyst or a dilated fourth ventricle. The collapse of this cyst gave ample room for further exploration. A true cystic tumor was disclosed in the upper lateral aspect of the angle. This was opened and yellowish fluid appeared. At the same time a frank hemorrhage was encountered from the petrosal vein. This was controlled after some difficulty with packing and muscle graft. When the hemorrhage was controlled, the packing was removed and the field reexplored. A cystic tumor, through which the seventh and eighth nerves apparently passed, was dislodged from the upper angle and freely opened. In attempting to remove the tumor from its fixed base a small artery was ruptured. This was clearly seen, but offered great difficulty because of its depth, and it was

impossible to apply a silver clip. Muscle graft was placed over the artery and hemorrhage controlled. Further disturbance of the tumor attachment seemed unwise, as the patient's blood pressure and pulse were unobtainable. Transfuision of 300 cc. whole blood and intravenous of 250 cc. saline, and 50 cc. of 50 per cent glucose reestablished satisfactory circulation and blood pressure. The cyst was removed at its base. The field was carefully inspected for bleeding and complete hemostasis obtained. The dura was closed with interrupted silk and skin flap in the usual manner with silk, subcutaneous and cutaneous. The patient's condition on leaving the operating room was satisfactory; talking and apparently none the worse for the procedure. It was remarkable to note within six hours, movement and twitching in the left angle of the mouth occurred, and apparently some function in the seventh nerve still remained, although prior to operation none could be demonstrated.

Neuropathologic Report.—Microscopical description: The structure of this tumor is made up of a fine, fibrillar network in the meshes of which are large globular cells with eccentric nuclei, whose cytoplasm shows a definite granularity. These cells resemble to a marked degree the nerve cells of the various ganglia of the body, but the external cellular ring is absent. There are no Nissl bodies visible. Nerve fibers cannot be made out with the ordinary staining methods.

Microscopical diagnosis: Ganglion neuroma (Dr. N. W. Winkelman).

Postoperative Progression Notes (3/13/30).—At 5 P. M. patient fairly well. Holding up fairly well. Bandages becoming slightly saturated. 3/14/30: At 8 A. M. condition excellent, but since operation patient cannot read. Can see to count and recognize people, but cannot read letters. 3/15/30: Good condition. Has some difficulty in saying what she means. Understands perfectly, but uses wrong words in speech, "jargon aphasia." 3/16/30: General condition excellent. Marked pulsation in neck and on close inspection, marked rhythmical throbbing of head. Has tired feeling. Complains of pain in left eye. Examination reveals a conjunctival infection associated with a circumcorneal infection. Cornea shows a flat ulcer, extending from the lumbus as about eight o'clock toward the periphery area. Pupils contracted and react sluggishly to light and in accommodation. Treatment outlined. 3/17/30: Eye feels better. Conjunctiva still injected. Ulcer stained with mercurochrome. Pupil dilated and immobile. Thirty cc. of 50 per cent glucose given intravenously. Feels good generally, but still is unable to read. 3/18/30: Incisions of transfusion wounds and infusions redressed. Stitches removed. Perfectly clean. Eye feels better. Corneal ulcer is not spreading and is partly filled in. 3/20/30: Left ear examination (Dr. Winston): There is considerable blood clot in the external auditory canal which, when removed, left a red ulcerative area in the external auditory canal. The ear drum is normal in appearance. The right ear is normal in appearance. 3/22/30: Patient complains of shooting pains behind left ear up over left parietal region and down into lower left face (returning function in fifth nerve). There is slight function of seventh, left corner of mouth can be drawn to left a little. Generally seems to be doing well. Urotropin and sodium discontinued because of nausea. 3/26/30: Cornea shows infiltrated area at seven o'clock. There is decided improvement in the corneal ulcera-

tion. 3/30/30: There is now, instead of hyperesthesia of face, an anesthesia with complete absence of fifth motor function. Histology of lesion of ganglioneuroma would fit in with after-picture with this patient. There has been considerable improvement in all other functions. 4/2/30: Patient seems to have a slight nasal congestion for past two days. Incision does not seem as good in places. General condition good. Sleeps well and eats likewise. Patient easily excited and when this condition exists, she has a vomiting spell. 4/7/30: Patient feels fine. Incision crusted on top and complains of pain in left eye, which is dilated. Evidence of a beginning opacity and corneal injection. Incision line cleansed with ether and touched with iodine. Healing slowly. Infection is superficial only. 4/18/30: Patient discharged in good condition.

Case III.—P. B., male, aged thirty years, admitted to Episcopal Hospital, January 30, 1930.

Chief Complaint.—On admission the patient complained of severe headache and vertigo.

Present Illness.—Was in good health until 12/18/29, when he had an attack of vertigo prior to retiring. He slept well that night, but awakened the next morning with vertigo and a throbbing headache, as well as nausea and vomiting. He was in bed several days and the physician diagnosed his case as nephritis. Since then he has been out of bed, but is not able to work. Still complains of vertigo, a throbbing headache, nausea, and vomiting, with increasing weakness. He urinates dark urine during the day. Has no pain or difficulty in starting the stream. He also complains of numbness of the left thigh, anteriorly.

Past History.—Patient had chickenpox and measles. Chorea in 1911. General health has always been good. Never had operation or any injury.

Family History.—Father died of pneumonia. Mother, three brothers, and three sisters living and well. One brother died in infancy. Wife living and well. No children.

Physical Examination.—Well-developed male, aged thirty years. Ears, nose, and neck negative. Eyes show a slight external rotation of the right eye. Left pupil, 2 mm., responds to light and in accommodation and convergence. Right pupil, 4 mm., responds to light and in accommodation and convergence. The left, however, shows a small white spicule attached to the upper margin of the iris. Mouth: mucous membrane normal. Tonsils show the pillars torn loose and dependent at their lower part. Chest: râles at the right base anteriorly; chest otherwise physiologic. Heart is normal, no murmurs. Extremities are negative.

Neurological Examination.—Patient shows definite signs of asynergia when placed upon the floor and in attempting to rise he cannot do so without assistance. Finger-to-nose test on each side is slightly ataxic. In walking he tends to stagger to the right. Nystagmus is not present. He is dull mentally and responds slowly. No intrinsic paralysis of the upper or lower extremities. The reflexes in the lower extremities are diminished, but not absent. Cranial nerves are normal. No corneal anesthesia. Sensory examination for pain, touch, position, and vibration is normal.

Special Reports.—Bárány test (Dr. Lewis Fisher): Suspicious of a cerebellar lesion (left). Cystoscopic shows small firm, clean prostate.

x-Ray findings: Increased density in the left antrum due to pathologic involvement. Skull shows normal sella. There is a calcified pineal body present. Convolutional and suture markings normal. There is increased intracranial pressure or evidence of a brain tumor shown.

Operation (2/29/30—Dr. Temple Fay).—Left transtentorial craniotomy. A horseshoe incision was made at the base of the neck. The galea and scalp rapidly reflected with general oozing due to intracranial pressure. The left ventricle was tapped and clear, colorless fluid, under great pressure, encountered. Bleeding was controlled and a bone, 5 by 5 cm., removed down to the lateral sinus. The dural flap was opened with grayish exudate in the sulci. A pacchionian body was encountered and ligated, entering the lateral sinus. The left occipital lobe was then elevated, exploration made to the crus, including the pineal, cisterna venae magnae cerebri. The left cerebellar hemisphere was bulging, soft, and swollen. The cerebellopontile angle was negative. Cerebrospinal fluid was encountered. The cisterna pontis tentorium split from the incisura to the lateral sinus and then back to the torcular. Wide decompression of the tentorium made. A cannula was then introduced into the boggy cerebellum, but no fluid was encountered. The vermis was explored and found to be negative. The anterior surface of the cerebellum was explored and also found to be negative. The patient's condition was good throughout the operation. The blood pressure never fell below 98, and was mostly above 114. Exploration was uneventful except for one cortical vein hemorrhage, which was controlled by muscle graft. Before operation 50 cc. of glucose was given, then 50 cc. of glucose and 250 cc. of saline given after the operation.

Progression Notes.—2/8/30: Pupils unequally dilated, right 7 mm., left 3 mm. 2/12/30: Spinal puncture, pressure remained at 40 mm. No ill effects. 2/14/30: Vomiting. 2/15/30: Suffering with intense headache localized in occipital region, vomited. 2/16/30: Condition the same. Had tests for sense of smell. 2/19/30: Swelling of disks bilaterally to 3 diopters. 2/20/30: Severe headache for past thirty-six hours. Had lumbar puncture. 2/22/30: Has bad ache at neck, and headache. Has distinct lateral nystagmus. Is disoriented for time. 2/23/30: Condition unchanged. 2/25/30: Headache less, and clearer mentally. 2/26/30: Choking of disks 4 diopters, bilaterally. 2/27/30: Rapidly worse, terrific pain in left occipital temporal region. 2/29/30: Left transtentorial craniotomy. Patient stood operation well. 3/1/30: Postoperative condition excellent. 3/2/30: Satisfactory condition. Complains of pains in head, is restless. Talks rationally. 3/3/30: Improving. Temperature 101 F., respirations 28, pulse 120, blood pressure 102/52. 3/4/30: Improved, but restless. Moved from bed and put in crib. Incontinent since operation. Right pupil dilated twice the normal size. 3/5/30: Drowsy, condition alarming. Blood pressure 90/40. Symptoms of bronchial pneumonia present. Stuporous, but can be aroused. Pulse 140, rate 40, temperature 106.2. Sudden rise in temperature and pulse with myosis and paralysis of right hand suggest hemorrhage in peduncle or pons. 3/6/30: Patient died at 8.32 A. M.

Diagnosis.—Subcortical glioma, left cerebellar hemisphere involving peduncle.

Discussion.—The diagnosis was difficult to make in this case because of the few local symptoms, the headache, vomiting, and periodic attacks probably being due to intermittent obstruction of the aqueduct by the tumor which proved to be the size of a walnut, completely filling the fourth ventricle. The intense intracranial pressure and choking of the disk indicated the probability of a posterior fossa lesion, although difficulty in differentiating the few cerebellar signs from those of the opposite frontal lobe was confusing. The Bárány gave the only clue as to the laterality of the lesion and as the autopsy disclosed the tumor as being in the midline, this would have made exploration from either side possible, its subdural situation made it impossible to remove. The case is of distinct interest in that the transtentorial approach was used and gave an adequate decompression to the cerebellum, as well as an immediate postoperative recovery which was satisfactory. The sudden death occurred after transferring the patient from one bed to another in which it was reported that he fell and struck his head. The orderly on duty could not give a clear account of what had happened. Immediate signs of a pontile hemorrhage ensued as evidenced by the rapid rise in temperature, a paralysis of the left side of the face, of cortical type, and paralysis of the right arm and leg. All efforts to control the rising temperature and falling blood pressure were unavailing, and the patient finally developed pulmonary edema and died on the eighth day following operation.

Autopsy revealed the central location of the tumor, as well as a laceration of the parieto-occipital portion of the brain which had herniated against the former decompression. From the necropsy report, a small purulent collection was found. It will be noted in the operative report that a green exudate was present at the time the dura was opened. This may or may not have been an error in technic. It was not, however, a determining factor in the outcome of the case.

Case IV.—E. P., female, aged forty-one years, admitted to Temple University Hospital May 20, 1930.

Chief Complaint.—Paralysis of entire left side of the face. Occipital headache and staggering gait.

Present Illness.—Headaches began in October, 1929, only on stooping. No headache if head was held still, motion of head in any direction produced this headache, sharp and vibratory in nature, lasting only several seconds. Had many infected teeth extracted in March, 1930. Headaches at times spread to vertex on stooping over. Has been more severe recently. Has lost power of left eyelid, eye is constantly open and has caused considerable irritation. Has noticed a tendency to walk to left. No vomiting.

Past History.—Measles, chickenpox, mumps, and diphtheria as a child. Typhoid fever at thirty-five years. Breast amputation (left) for tumor, April, 1930. No previous mental condition.

Family History.—Father, mother, and two brothers living and well.

Physical Examination.—Fairly well-nourished female. Head, grossly negative. Eyes, pupils are dilated, regular, equal, react to light and accommodation, left more sluggishly, ocular movement full, lateral nystagmus. Lagophthalmos of left eye, inability to fully close eye. Conjunctivitis and epiphora of the left eye. Ears and nose are grossly negative. Mouth, considerable artificial denture. Gums show some pyorrhea. Tongue is clean, protrudes in midline, no tremor. Tonsils small, but infected. Neck is negative. Chest, there is a scar on the left side from recent left-breast amputation. Lungs, there is some dulness at the left apex. Breath sounds normal. Heart, borders in normal limits, sounds fair, and regular. Suggestion of soft systolic murmur at apex. Abdomen is grossly negative. There is no gross pathology of the extremities.

Neuromuscular: There is marked paralysis of the left face, peripheral type, including articularis oculi. No sensory disturbance. Upper extremities: the reflexes are equal, and normally active. The finger-to-nose test is negative. Lower extremities: the reflexes are equal and normally active. There is no Babinski or ankle clonus.

Eye Examination.—5/20/30: O. D., palpebral fissure wider than that of left one. O. S., lagophthalmos. Slight ectropion of lower left lid with reddening of margin of same lid. Conjunctiva of left eye, slightly injected. Cornea a bit hazy. O. S., anterior chamber is normal. Pupils are round, 5 mm., react to light, accommodation, and consensually. Muscle movements and convergence, full. Slight nystagmus present in extreme lateral fields of rotation. Tension is normal.

Fundus: O. S., media not clear, due to irregularity of the anterior surface of the lens and the presence of an air vacule of the same lens. Disk, oval, hypermic, with hazy poles and a hazy temporal margin. Slight circumpapillary haze. Disk details are not discernible. No swelling of the disk. Connective tissue tags are present on the disk, which do not obliterate disk details. The vessels are 2 : 3 (artery vein ratio). Veins are overfull, slightly tortuous. Arteriovenous crossings present without compression; no variation in vessel caliber. No hemorrhages, no exudates seen in the periphery. Macula, fine granular. O. D., media, clear. Disk is oval, slightly hyperemic

with hazy details of the disk, with blurred poles, as well as of the upper part of temporal margin. Narrow circumpapillary haze. Few connective tissue tags seen on disk. Vessels are less overfull, especially veins. Periphery is like its fellow. Macula, very finely granular. Summary and impression: Seventh nerve paresis (peripheral); ectropion (slight). Nystagmus, neuroretinitis, more marked in O. S. Myopic astigmatism. Recommendations: Field studies. Slit lamp study. Local treatment to the eye will be outlined.

Reexamination of fundus: Does not reveal swelling of the disks, although the left disk is 1 D. higher than the right.

Slit lamp study, 5/21/30: O. S., cornea shows areas of superficial denudation of the epithelial surface. No signs of infiltration. Aqueous normal. Iris, normal pattern seen. Lens shows very superficial irregularity in the subcapsular layer, and a few isolated white brilliant spots in the adult nucleus. O. D., no abnormalities seen.

Special Reports.—5/20/30: Bárány test. Spontaneous nystagmus on looking in all directions. There is a marked diminution in the duration of nystagmus and vertigo after turning with a disproportion between the two. The right ear responds fairly well to caloric stimulation in all of its portions. Hearing is good in this ear. There is a total loss of vestibular function from the left ear. Hearing is markedly impaired in this ear. The findings strongly indicate the presence of a brain mass lesion. The findings are not typical of those observed in an angle lesion, but rather suggest a lesion involving the left cerebellopontile angle secondarily. Conclusions: I believe we are dealing with a lesion high up in the brain stem involving the left cerebellopontile angle secondarily.

x-Ray findings, 5/20/30: Part of the frontal area, with extension upward along the frontoparietal suture on the right side, shows evidence of rarefaction. There are numerous calcifications in the pacchionian area. The sella turcica is shallow, appears mottled, with an area suggesting calcification. The frontal sinuses are very large and prominent.

Lumbar puncture, 5/22/30: Initial pressure 14 mm. mercury. Coughing made pressure rise to 16 mm. mercury. Jugular pressure, right, with no rise. Jugular pressure, left, with no rise. Bilateral pressure rose to 18 mm. mercury, and remained at 18 mm. mercury. Coughing and straining caused slight millimeter rise. Fluid clear and colorless.

Diagnosis: Increased intracranial pressure.

Gruskin test: Hemolyzed so that test is unsatisfactory. Hollinsworth 2 plus positive.

Operation (6/4/30—Dr. Temple Fay).—Exploratory transtentorial craniotomy. After the usual scalp preparation, an occipital flap was so designed to expose the temporal and occipital lobes at the left of the lateral sinus, carrying the bone opening close to the mastoid. The incision was extended parallel to the midline to the nape of the neck and as high as the parietal area, thence laterally to just above the ear and posteriorly over the tip of the mastoid. The oblong bone flap thus described was broken back without difficulty. The posterior fossa was exposed after freeing the muscles by removal of the bone over the cerebellum on the left. The dura was then opened and the large venous channels connecting the occipital lobe with the

lateral sinus. Three large collections of veins were ligated after careful exposure and the occipital pole freed and elevated. The tentorium at once appeared and seemed extremely firm and hard in the region of the lower part of the petron, extending toward the posterior clinoid process at the angle. The involvement lay below the tentorium. The occipital lobe was entered by a brain cannula, and clear, colorless fluid escaped from the posterior horn of the ventricles. The lobe was then elevated and the incisura of the tentorium disclosed. Silver clips were placed on each side and a section of the tentorium revealed the upper surface of the cerebellum and the cerebellopontile angle. A gristle-like tumor, flat, and firmly attached to the dura, was exposed in the outer portion of the cerebellum. The tumor invaded the cerebellar hemisphere, and was about the size of a walnut. The infiltrated part of the tumor involved the eighth nerve and the dura along the sigmoid sinus. It was evident that an infiltrating lesion, probably metastatic in origin, was present, and because of its firm attachment to the lateral sinus, this structure was ligated and sectioned, and the cerebellum was thus freed from its tentorial roof above and its lateral confines of the sinus. The tumor was then removed by partial finger dissection and electric cautery. The eighth nerve sectioned and a bulbous tumor of this structure removed by electric cautery. A dissection of the invading thickened plague from the lateral sinus and sigmoid was made by the electric cautery, and removed completely. The attachments and base of the tumor were fulgurated. Hemostasis was controlled. The tumor bed was inspected; stumps of the lateral sinus doubly ligated and the bone flap replaced with a silver wire fixation. Under skin and subcutaneous closure with silk. Decompression of the angle and posterior fossa permitted. The dura was sewed intact along the parietotemporal margin. Drainage introduced in the upper portion of the wound. During the procedure the patient received 60 cc. glucose and 200 cc. saline. Later 300 cc. citrated blood were given. The time of the operation was four and one half hours.

Neuropathologic Findings.—Microscopical description: A frozen section shows in the soft portion of the tumor collections of epithelial cells grouped in large islands, with a tendency to group around a small open space, forming pseudoacini. The morphology of the individual cells fits in with the epithelial tissue with small amounts of chromatin and numerous mitotic figures. In one hard nodule within the dura are small nests of cells that have become modified in their appearance as a result of being wedged in connective tissue, though it does have the appearance of a sclerosing cancer.

Microscopical Diagnosis: Metastatic carcinoma of the brain (Dr. N. W. Winkelman).

Progression Notes.—5/20/30: Patient comfortable in bed. Reexamination of fundus. 5/21/30: Slit lamp study of eyes. Blood count. 5/22/30: Lumbar puncture. 5/23/30: Condition good. No effects from lumbar puncture. 5/24/30: Condition unchanged. 5/25/30: Discharged. Condition unimproved. 6/1/30: Patient readmitted for operation. 6/2/30: Blood taken for complete count. 6/4/30: Exploratory craniotomy. 6/6/30: Patient responded fairly well from operation. Temperature, pulse, and respiration have gradually returned to normal. Has difficulty at times in obtaining

the right word. Nausea especially on moving from side to side. The left facial weakness is improved, and the patient can close the eye, and draw up the corners of the mouth. Drain is removed and the patient refuses food and is given fluid by enemas. 6/7/30: Patient complains of pain over bladder region. There is no marked distention. Catheterized. Condition good. 6/9/30: General condition good. Temperature, pulse, and respiration, and blood pressure normal. Complains of weakness of left arm. Recovering most of the facial weakness of the left side. 6/13/30: Condition unchanged. Left arm stronger. Shows an alexia, being unable to recall letters of the alphabet. 6/15/30: Feels stronger, out of bed. Very little residual paralysis of the left face and eyelid. Alexia persists. General condition good. Discharged.

Case V.—Mrs. A. F. D., female, age twenty-five years, admitted to Temple University Hospital, June 6, 1930, referred by Dr. Weston D. Bayley.

Chief Complaint (6/2/30—notes by Dr. Weston D. Bayley).—Has had hay fever and rose cold. Dr. Mackenzie operated on nose for that. Was brought to Dr. Mackenzie in March, 1923 for distress in the right ear and impaired hearing. This proved to be tumor in the tympanum. Radical mastoid operation, tumor removed, severe hemorrhage (jugular bulb). Dr. Sappington, 6/5/27, diagnosed "cellular fibroma of the polyp type, or possible sarcoma." Puberty at twelve years. Mentally depressed and nervous. Was out of school for a year. Father says she would never go away from home, and did not do so until she married and went south. No pregnancies. Dr. Mackenzie examined her eyes in July, 1925. Fundus normal then. Again in 1927, similar observations. Findings today (6/2/30): Pupils react, left a shade larger than the right. Direct examination: O. D., disk swollen, several small hemorrhages at edge or disk margin. Swelling of disk is about 3 diopters. O. S., same general appearance as O. D. Disk swollen, with blurred outlines. Engorgement of veins.

Present Illness (6/2/30—Dr. Weston D. Bayley).—Patient free from headache until four months ago. They then developed severe, throbbing, with maximum intensity, centrally in occipital region, extending from thence sometimes on one side, sometimes on the other side, sometimes bilaterally over the vertex to the orbits. These are worse in the morning, and may awaken her from sleep. There has been much nausea, and some vomiting mostly early in the morning. She has thus vomited daily for a period of weeks, often without nausea. The vomiting, as described, is not projectile; but the impulse of vomiting may start a headache, as above described. There has been no diplopia, tinnitus, nor vertigo. She describes that after a long train trip last July, for three weeks, objects viewed appeared to be rapidly moving up and down vertically. This same experience was noted last January, continuing for five weeks, but it has not recurred since. She has not noticed any local twitchings nor weakness. Is right-handed, although she remarks that in some respects she was earlier ambidextrous. Has had no attacks of disturbed consciousness, nor speech difficulties. She remarks that there has been some pain in the left molar region, which she attributes to an upper tooth, but that all *x*-ray studies of her mouth have been negative,

and the tooth is not devitalized. Patient is nervous and apprehensive because of our present detailed studies of her.

Physical Examination (6/2/30—Dr. Weston D. Bayley).—Slight build, looks to be in fair health. Pupils appear equal and react normally. No nystagmus. Muscular system poorly developed. Dynamometer grasps 40 in both hands. Muscle groups of all limbs studied by resistence show no localized weakness. Slight static ataxia in Romberg position. Deep reflexes are very free, especially the right arm and leg. No ankle clonus. No sensory phenomena. Bilateral choked disks. No involvement of those of seventh nerve on operated side. 6/4/30: The tricep and forearm reflexes, which two days ago appeared much more active on the right side, are reexamined today and not verified. Conference today with Drs. Mackenzie and Post, who bring roentgenograms of head; one showing apparent pathology on upper margin of petrous outward from the internal auditory meatus. The margin appears ragged as compared with opposite side, and there is a small shadow adjacent to this. It is decided to have a conference with Dr. Temple Fay. 6/6/30 (notes by Dr. Temple Fay): There is no evidence of ocular weakness on either side. No sustained nystagmus. Slight deviation of both sides in the lower movements. Fundi show elevation of the disks with exudates and hemorrhages. Pupils are equal, respond promptly to light and accommodation. There is no facial weakness or relaxation. The eyes close firmly, both volitional and emotional. No sensory involvement of the trigeminus. No disturbance in the movements of the tongue. Voice light (test vagus). Right hyper-reflexia of tendons, with slight dysmetria on the right. Opinion: The patient appears to have signs of increased pressure, history of tumor removed on the right, deafness and *x*-ray changes, probably acoustic neuroma. Advise exploration.

Progression and Consultation Notes (6/7/30—Dr. Temple Fay).—Spinal puncture pressure in prone position, 20 mm. mercury. Pressure rose to 22 mm. by pressure on the right jugular, to 24 by pressure on the left jugular. One cc. removed for cell count.

Eye examination (6/7/30): O. U., 20/20–1, with glasses. O. D., 20/40, plus 3. O. S., 20/40, plus 2. No ptosis, no paralysis. Conjunctivae slightly injected; shows negative through a pale bluish sclera. Cornea is clear. Anterior chamber is normal. Pupils are unequal. 4.5 mm. (O. D.), 4.75 mm. (O. S.). React to light and in accommodation and consensually. Muscle movement and convergence full. Tension is normal. Fundus, media is clear. Disk is swollen to the extent of 5 D. and 6 D. (O. D. and O. S.), with numerous flamelike and deep hemorrhages, with exudate around the disk and in the vicinity of the left macula. Swelling of the disk in obscure part of the vessels. The latter are congested and tortuous. Impression: We are dealing with a case of choked disk, as a result of increased intracranial pressure. Reexamination of eyes, 6/11/30: No change in the amount of choking, namely, 5 and 6 D. (O. D. and O. S.). 6/12/30: Cranial exploration. Vascular tumor found supratentorially, not removed because of patient's condition. Condition following operation very grave, but reacted well.

Operation (6/12/30—Dr. Temple Fay).—Exploratory transtentorial craniotomy. Exploration, with attempt to remove tumor. A combined oc-

cipital and posterior fossa flap was designed so as to expose the temporo-occipital surface and the right cerebellar hemisphere. After great difficulty because of sclerosed bone at the base, a satisfactory exposure was obtained. The flap broke high, and required a second breaking. This exposed the cerebellar fossa, as well as the occipital lobe. The dura was then turned to the lateral sinus. Many large vessels were present between the occipital lobe and the tentorium. These required careful section. The tentorium was then inspected and found to be split. It was full and bulgy. The incisura was opened. Bleeding from several large vessels complicated the field. The tumor mass was disclosed in the angle and because of the hemorrhage encountered, the posterior fossa was opened; the lateral sinus ligated, and a large colloid and angiomatous tumor revealed. The vessels were extremely thick and numerous. A large arterial plexus was present on the lateral surface of the tumor, and many venous channels were woven into the mass. Attempt to displace the tumor was followed by hemorrhage. After several unsuccessful attempts to define this tumor mass, the operation was concluded because of the patient's general condition. Hemostasis was controlled. The bone flap was replaced. Closure of the muscle and subcutaneous layers with silk as usual. A small rubber drain was introduced in the posterior aspect of the wound. The operation was completed in five hours. Transfusion of 350 cc. citrated blood plus glucose. Infusion of glucose given during the operation. The patient's condition upon return to the room was poor, although blood pressure 80/70 could be obtained.

Diagnosis: Hemangioma of the right cerebellopontile angle. Mucoid degeneration, cystic in character.

6/13/30: Condition fair. Pulse better volume. Talks rationally. 6/14/30: Condition about the same. Redressed, tube removed. 6/15/30: General condition good. Temperature, pulse, and respiration remain near normal level. Seems drowsy most of the time. 6/16/30: Patient has been somewhat drowsy since operation. She is, however, clear and oriented. The wound is healing nicely. Pulse and blood pressure within normal limits. Patient is somewhat nauseated at times. There is possibly a left homonymous hemianopsia to gross tests. Patient to have second stage operation in morning if her condition permits. 6/17/30: Complaint of diplopia today. Nystagmus marked. Left sixth nerve weakness (Dr. N. W. Winkelman).

Eye Examination (6/17/30—Dr. Gouterman): Definite nystagmus in the extreme lateral fields. A rough test of the diplopia field failed to reveal any definite muscle involvement, although the left sixth appears paretic. Disks are 5 D. and 4 D., swollen. A narrow temporal sector of the left disk is distinct enough to expose its details. There is a decided improvement in the choking of the disks.

Patient still complains of diplopia. Condition about the same as yesterday. Patient drowsy most of the day. 6/18/30: Cornea denuded to a variable depth. Fundus shows contracted vessels, especially of the arteries, but none is empty (Dr. Temple Fay).

Operation (6/18/30—Dr. Temple Fay).—Transtentorial craniotomy (re-exploration). The former incision was opened rapidly and the bone flap reflected. The occipital lobe was found to be herniated and contused through

the decompression opening. The cerebellar hemisphere was also herniated. It was difficult to open the dura because of its tension. A hemorrhage was found in the occipital pole, which was evacuated. The contused cerebral cortex was carefully removed and an exposure made of the cerebellopontile angle. The tumor was disclosed with many vascular attachments. It was hard in the center and extended deeply into the posterior fossa. One of the branches of the tumor apparently grew into the jugular foramen and vagus branches and a nodule passed anteriorly around the posterior clinoid. With difficulty the roots of the tumor were sectioned by the aid of the cautery and the mass was enucleated. Bleeding occurred at several stages and was controlled with warm saline solution and muscle graft. An angiomatous capsule was then traced back, deep into the angle to its origin in the pons. It was severed at this point. Shock was sufficient to require transfusion and glucose. The patient's condition improved and the wound was closed, with the bone flap removed, and with ample room in the posterior fossa for any increase in pressure. It was found that the deep vascular supply around the pons, and, especially as the tumor passed anteriorly under the pons, might involve branches of the basilar artery. The wound was rapidly closed with interrupted silk sutures, and a drain was left in the lower segment. The operation was completed in three hours. The patient's condition upon leaving the table was poor. The patient died at 2.25 P. M. Cause of death: Cardiorespiratory failure following removal of tumor tissue.

Discussion.—The first 2 cases undertaken seemed hopeless from the standpoint of the patient's desperate condition and the former operative failure by the suboccipital route. In each case it was felt that the objective should be a decompression by section of the tentorium. Little hope was held for the possibility of dealing with the tumor as the patient's condition did not seem to warrant such a formidable procedure. With the section of the incisura and the tentorium, the exposure of the tumor was adequate, and its removal required only a short time following which the patients made a rapid and uneventful recovery. The slight reaction to this procedure was one of the astonishing features, and although a bone flap was not devised in either case as there was a feeling that the decompression was all that could be hoped for, the resultant cranial defect became the only regret in these cases as there followed no herniation or subsequent intracranial pressure, but, on the contrary, a noticeable depression.

The subsequent 3 cases represented the devising of a bone flap. In the third case I encountered a large bulging cerebellum after the tentorium had been sectioned. A cannula introduced

into the hemisphere indicated the tumor to be subcortical. On the night of the seventh day the patient was transferred to another bed and allowed to fall striking his head, following which paralysis of the right arm and leg appeared promptly with a rapid rise of temperature and vasomotor failure. Hemorrhage of the pons was suspected and the patient died four hours later. Necropsy revealed a tumor about the size of a walnut situated in the midline invading both cerebellar hemispheres.

The fourth case was one of metastatic carcinoma of the cerebellopontile angle and posterior fossa. The removal of the mass of the lesion by the electrocautery and the prompt and rapid postoperative recovery were in striking contrast to the usual reactions in such an extensive exploration. The removal of the lesion as far as possible was also in marked contrast to the usual attempted removal of such gross invasive tumors, and fully demonstrated the value of the transtentorial approach.

The fifth case represented a most difficult hemangioma which required a two-stage operation after its adequate exposure by the transtentorial route. In this case it was interesting to note that the tentorium had already given way and had split, due to the pressure of the tumor, so that it was necessary only to divide the incisural ring and to enlarge the rent already present. The lateral sinus was ligated because of its vascular connections with the tumor. This is the first case that has come to my knowledge in which the tentorium had spontaneously decompressed the posterior fossa by rending the dural membrane, and may account for the few symptoms disclosed by the patient in the presence of a large tumor, aside from those due to general intracranial pressure.

The method offers a solution of the intracranial pressure problem met with in cerebellar and cerebellopontile angle lesions from three angles, (*a*) suboccipital decompression; (*b*) supratentorial decompressions, and (*c*) removal of the constricting and strangulating point in the cerebrospinal fluid pathways to the vertex.

Although the technical difficulties encountered are greater and more time consuming than the suboccipital approach, still in

my opinion the procedure is associated with less postoperative reactions than the midline suboccipital approach, and cases which present "inoperable" tumors or extensive lesions of the posterior fossa can be more adequately dealt with by this method.

CLINIC OF DR. EUGENE P. PENDERGRASS

From the Department of Roentgenology, Hospital of the University of Pennsylvania

THE VALUE OF AND INDICATIONS FOR ENCEPHALOGRAPHY AND VENTRICULOGRAPHY, WITH DISCUSSION OF THE TECHNIC

Many brain lesions give a few or no localizing signs even though they have been subjected to repeated thorough neurological examinations. Dandy states that approximately 40 per cent of brain tumors can be localized by neurological methods and that assistance from routine roentgen examinations of the head may be expected in only 10 to 15 per cent of the cases. Frazier feels that Dandy's percentage of localization of brain tumors by neurological methods is too low. He states that his percentage of localization is from 60 to 70 per cent by neurological examinations without the aid of the roentgen examination. Cohen, working in our laboratory, analyzed 221 cases of patients suffering from brain tumors who had been referred to us by the Neurological and Neurosurgical Divisions of the University Hospital for roentgen examinations of the head. The tumors of these patients were distributed as follows: 97 in cerebrum, 65 in and around the pituitary fossa, and 59 in the cerebellum. All of these cases had the usual neurological and roentgen examinations. In addition, all were operated upon and a microscopic verification of the tumor was substantiated.

In the 65 pituitary lesions it was possible to make a correct clinical diagnosis in 55 cases or 84.6 per cent. The roentgen diagnosis was accurate in 58 cases or 90 per cent. Correlation of the clinical and roentgenographic findings raised the percentage of accurate diagnosis and localization to 64 cases or 98.5 per cent.

In the group of 97 cases of cerebral tumors, 46 cases or 47.4 per cent were diagnosed clinically, and of this number, 32 cases or 33 per cent were accurately localized. There was roentgen evidence of increased intracranial pressure in 55 cases or 56.7 per cent, and in 26 cases, or 26.8 per cent, the tumor was localized.

In the group of 59 cerebellar tumors, 48 cases or 81.4 per cent were correctly localized by clinical examinations. The roentgen diagnosis was of localizing value in 30 cases or 50.8 per cent.

It is appreciated, therefore, that even in brain tumors there is an urgent need for more accurate methods of localizing the lesion as the mortality from unlocalized brain tumors is 100 per cent. There are a number of other brain lesions that give no localizing signs and if they do, sometimes simulate brain tumors, and still others that do not give any positive neurological findings. In an effort to diagnose and localize the various brain lesions more accurately, Dandy in 1918–1919 was the first to describe and popularize two procedures—*ventriculography* and *encephalography*.

VENTRICULOGRAPHY

Ventriculography is a procedure in which a series of properly exposed roentgenograms are made of the head in several positions in the horizontal posture within one hour following the removal of all of the available cerebrospinal fluid from the ventricles of the brain and its replacement by air.

Technic.—The success of the procedure depends upon the neurosurgeon and the roentgenologist. The neurosurgeon must drain off all of the available cerebrospinal fluid from the ventricles and the roentgenologist must make technically perfect roentgenograms.

The operative technic varies with different surgeons. Grant prefers the following technic:

"Under local anesthesia, two small trephine openings are made in the skull 7 cm. above the occipital protuberance, and 2 cm. lateral to the midline. From this point the needle is introduced horizontally in the plane of the tip of the ipsolateral ear and slightly laterally. Normally the ventricles should be

entered at a depth of from 4 to 5 cm. from the surface. The posterior approach has three advantages. The cannula passes through a relatively silent cortical area above the visual tract and behind the sensorimotor centers; the vestibule of the lateral ventricle is entered, where the anterior, posterior, and inferior horns unite, which is its widest point, and consequently least likely to be collapsed by pressure; most important of all, through this approach nearly all the fluid in the ventricle can be drained by tilting the head backward. It is essential to remove all the fluid possible, for unless this is done, one cannot be sure that a defect in the ventricular outline is due to an actual lesion and not to fluid trapped in one or another horn. Rotation of the head from side to side will in part prevent this, and insure more complete drainage. But by far the larger number of our mistakes and failures accurately to localize the lesion have been due to incomplete filling of the ventricular system with air." At the time of the drainage the fluid is measured and by this method presumptive evidence as to the size of the ventricles is obtained. The normal ventricles usually contain approximately 60 cc. of fluid. After the ventricles are drained and the head is tilted backward and rotated, mild pressure is made over the jugular veins, thereby increasing intracranial pressure, and therefore aiding in more complete drainage. After the fluid is withdrawn, air is sucked in because of the subatmospheric pressure in the ventricles. It may be unnecessary to inject any air. "In any event it is essential not to introduce air in a larger amount than that of the fluid removed. All manipulations must be accurately controlled by manometric pressure readings, and great care taken that the intracranial tension be not raised above the level found when the cannula was inserted."

Gardner and Frazier recommended the following technic: "The patient is placed on the table in the supine position. The shoulders are elevated on a pillow and the head is cocked forward by means of one to two small sand pillows under the occiput. The head of the table is tilted upward about 12 inches. A small perforation is made in the skull 6 cm. above the occipital protuberance and 3 cm. to either side of the midline. Cannulas are

introduced into each posterior horn and the pressure is estimated with a mercury manometer. This is followed by the injection of 1 cc. of indigo carmine into one ventricle. After a few minutes have been allowed to elapse for one diffusion of the dye, the fluid is allowed to escape slowly from the two ventricles simultaneously. If dye appears in the fluid from the opposite ventricle, it is assumed that there is communication between the two. The fluid is carefully collected from each ventricle and measured. When the fluid ceases to flow, the head of the table is lowered to the horizontal position and the head rotated to one side, so that one cannula is more dependent than the other. The lower cannula then acts as a siphon and as fluid flows from it, air is aspirated into the uppermost cannula. When the fluid again ceases to flow, the assistant is instructed to make intermittent jugular compression. With each compression of the jugulars, more fluid flows from the cannulas and as the pressure is released, air is aspirated into the ventricles.

"By this means it is possible to withdraw practically all of the fluid from the ventricular system. The withdrawal is accomplished slowly and at the conclusion of the operation the ventricular pressure is that of atmospheric air. The patient's condition usually remains satisfactory and postoperative headache is reduced to a minimum.

"If the patient's condition permits, it is easier to perform the procedure in the sitting posture. In this instance, the evacuation may be accomplished by merely tilting the head backward and slightly to one side. A greater siphon effect may be obtained if a section of water manometer tubing is connected to the lowermost cannula and allowed to hang downward."

Following the drainage of the ventricles and replacement of the fluid with air the cannulas are withdrawn and the patient is brought to the roentgen department on the operating table or chair. The patient is examined immediately, these patients being regarded as emergencies, and the routine of the laboratory is stopped in the room in which the patient is to be examined. Appointments are made in advance and everything is ready for the examination.

Roentgenographic Technic.—The patient is examined in the horizontal position. A designed Potter-Buckey diaphragm is placed above the patient's head and the *x*-ray tube is located beneath the table. This position affords the opportunity for the air to rise into the upper ventricle which is next to the film and any residual fluid to drain into the lower ventricle. By having the ventricle to be examined next to the film, the distortion is reduced to a minimum and the roentgenograms are interpreted with greater ease. Stereoscopic roentgenograms are made of each side and one in the anteroposterior plane and one in the postero-anterior direction. In both of the sagittal views it is essential to flex the chin on the chest, so as to prevent the frontal sinuses from being superimposed upon the air containing ventricles.

The patient lies on the side for the stereoscopic views, on the back for the postero-anterior view, and on the abdomen for the anteroposterior view. The head is held slightly in position by a restraining band. It is necessary to prevent rotation of the head, otherwise confusing distortions will occur. The films are developed immediately after they are taken and a wet plate reading is made as soon as possible so as to allow the neurosurgeons to proceed with the operation if one is indicated. The procedure is thought by some to be of distinct value in relieving posttraumatic headache. This has been explained as due to stretching of the subarachnoid membrane. Others feel that it is due to the removal of the cerebrospinal fluid.

Indications.—In the presence of increased intracranial pressure, ventriculography is the procedure of choice, in cases where the most careful neurological, roentgenological, ophthalmological, and neuro-otological methods fail to give satisfactory localizing signs of the lesion. This would include unlocalized brain tumors, brain abscess, basal arachnoiditis, or any condition causing a block of the ventricular system. The unlocalized brain tumors are usually located in the frontal lobes or the midline, some are located in the occipital lobes and the posterior fossa. It is important for the surgeon to know whether he is dealing with a supratentorial or infratentorial lesion, because his approach is

entirely different. The size of the lesion should be of importance to the surgeon as it would help him to plan the surgical approach. Ventriculography originally was used by Dandy to demonstrate the size of ventricles in hydrocephalus and indicate the point of obstruction.

In order to make a diagnosis of the lesion after ventriculography, the lesion must be located so as to deform or block the ventricular system. It is essential, therefore, that one should be familiar with the roentgenological anatomy of the brain and be able to use the stereoscope.

Contra-indications.—Patients who have unlocalized brain tumors or other lesions without increased intracranial pressure should not be subjected to ventriculography because of the high mortality associated with the procedure. According to Grant, it is at least 8 per cent, although in a recent paper, he states that in experienced hands, ventriculography is not a hazardous procedure.

Errors in Technic.—Failure to get satisfactory roentgenograms is scarcely excusable. Rotation of the head of an uncooperative patient should be guarded against, otherwise it is very difficult to interpret the roentgenograms. Failure to drain the ventricles is also regarded as an error in technic and we do not attempt to interpret such roentgenograms, as one is more likely to err rather than make a correct interpretation. It is difficult to interpret the roentgenograms even when the technic has been satisfactory, and the roentgenologist who makes a wrong interpretation on the roentgenograms after faulty surgical technic does harm not only to the patient, but in his attempt to do the impossible gives a false impression of the procedure and his ability to make a correct diagnosis.

Sometimes it is impossible to find the ventricles for surgical drainage due to some abnormality or displacement of the posterior horns. Obviously in these cases roentgenograms are of no value.

ENCEPHALOGRAPHY

Encephalography is a procedure in which a series of properly exposed roentgenograms are made of the head in several posi-

tions in the erect posture within one hour following the removal of all the available cerebrospinal fluid and its replacement with air by the cisternal or lumbar route.

Technic.—The success or failure of this procedure depends upon the neurologist, neurosurgeon, and roentgenologist. The neurologist or neurosurgeon must drain off all available spinal fluid and the roentgenologist must make technically perfect roentgenograms. Pancoast and Fay have outlined the following procedures with regard to the surgical preparation of the patient:

(*a*) The patient is placed upon a litter in a lateral horizontal position. A gold needle is inserted into the space between the fourth and fifth lumbar vertebrae. When clear colorless spinal fluid is encountered, a pressure reading is made at the beginning of the procedure. A second needle is then introduced into the space between the third and fourth lumbar vertebrae. After obtaining clear spinal fluid from this puncture, the manometer is disconnected and the stylets of the needles are replaced. The patient is then placed in the erect posture, great care being observed in maintaining the same relative curvature of the spine in order that the needles may not be disturbed. The normal pressure of the spinal fluid in the horizontal position is approximately 8 mm. mercury and in the adult the normal pressure in the sitting position is 20 mm. of mercury.

(*b*) A manometer is connected to the upper needle to allow one to have a constant reading throughout the entire procedure of drainage and replacement. The canal is drained through the lower needle. If, when the procedure begins, the pressure is 20 mm. of mercury, spinal fluid is allowed to drain into a graduate from the lower needle until the pressure becomes 10 mm. of mercury. Then a syringe of air is connected to the lower needle and the air is slowly introduced until the pressure rises to 20 mm. of mercury. This procedure is repeated until all of the fluid has been removed. It should be noted that the removal of fluid and the replacement with air is a pressure per pressure mechanism rather than a volume per volume. Air expands at body temperature, and every effort is made to maintain the pressure which was

present at the beginning of the procedure. It has not been found necessary to take any precaution in the selection of the air to be used, ordinary air in the room being introduced into the spinal canal.

(*c*) Fluid should never be sucked out of the canal, but should be allowed to drain. During the above drainage an assistant is rotating the head from side to side and from back to front as far as possible, taking care not to change the axis of the spinal canal. This rotation is most important, as upon this procedure depends the success or failure of one being able to drain the lateral ventricles. A satisfactory injection of air should require the withdrawal of at least 100 to 125 cc. of fluid in a normal adult. In our hands, adequate drainage of the cerebrospinal fluid by the cisternal route has not been possible, probably due to the danger of manipulation of the head with the needle *in situ*.

(*d*) After the canal has been drained the patient is placed in a wheel chair and taken to the roentgen department for examination. The head is maintained in the erect posture in a midline position so as not to allow any distortion from air seeking the highest point and possible residual fluid in the ventricle seeking the lowest point.

The following symptoms are usually noted in patients. After the introduction of about 40 cc. of air the patients develop severe frontal headache, this being an indication that air has reached the subarachnoid spaces over the frontal lobe. Following this, profuse sweating usually occurs. During the rotation of the head and emptying of the ventricles, vomiting may ensue. Slowing of the pulse may be encountered, and a pulse of 60 beats per minute is not uncommon. The headache is the disturbing factor to the patient, and chloral hydrate, 15 grains, is usually given to the patient one hour before the procedure to reduce the intensity of the pain. The headache is intense for six to eight hours, and present in a slight degree for twenty-four to thirty-six hours.

Roentgen Technic.—The essential feature of the roentgen technic is the use of a vertically placed flat Bucky diaphragm, as all films must be made in the erect posture and the roent-

genograms should be technically perfect with the maximum amount of contrast. Roentgenograms made without the aid of the Bucky diaphragm are useless in this procedure except in showing the ventricles. Finer details of the subarachnoid markings are lost or are so indefinite as to make interpretation difficult. Technically perfect roentgenograms imply the proper technic on the part of both the neurologist or neurosurgeon and the roentgenologist. Sufficient air must be introduced into the spinal canal and it must be properly distributed by proper manipulation of the head or incorrect conclusions may be drawn.

After the fluid has been withdrawn and the air introduced the patient is brought to the roentgen department and placed in a chair which has large casters on it so as to facilitate movement of the patient. Seven roentgenograms are made, lateral stereoscopic views of each side, stereoscopic views in the anteroposterior direction and one postero-anterior view. The stereoscopic shift for the lateral views are in a horizontal direction in order to prevent a distortion of the basal cisternae by superimposing the base of the skull. The anteroposterior roentgenograms are made by a vertical shift in order that there will be no shift of the midline structures. When making the lateral views the head is held tightly by a restraining band. In making the anteroposterior view the chin is flexed on the chest in order that the frontal sinuses are not projected over the air-containing third and fourth ventricles; otherwise they will be difficult to interpret. It is absolutely essential that the head be properly placed in both the lateral and anteroposterior directions; otherwise confusing distortions of the ventricles will be found on the roentgenograms.

The factors used in making the roentgenograms are as follows:

Fixed target film distance of 44 inches (111.7 cm.). This will allow plenty of room to manipulate the patient. The roentgen rays are approximately parallel, thereby causing a minimum of distortion.

The stereoscopic shift is 5 inches (12.7 cm.).

Kilovoltage 100.

Milliamperage 20.

Time for lateral views—six to eight seconds.

Time for anteroposterior views—eight to ten seconds.

In children and infants when they are under an anesthetic and it is imperative to obtain quick exposures, the factors are:

Kilovoltage 88.

Milliamperage 100.

Time two to three seconds for each view.

The Bucky diaphragm is placed in a vertical position on a special stand which allows it to be lowered or raised for various heights, and it can be angled in any position.

Indications.—The indications for encephalography include those cases in which symptoms are obscure, such as those following trauma, inflammation, and senility, epilepsy, hemorrhage, brain tumors, hemiplegia, and birth injuries. As encephalography is the replacement of spinal fluid by air introduced into the subarachnoid spaces surrounding the brain and within its ventricles, it is evident that encephalography is indicated in any condition of the brain or its surrounding structures which would distort or obliterate the subarachnoid fluid pathways. Many of these conditions cause very few or obscured symptoms and much information of importance has been obtained from employing this method.

Contra-indications.—The procedure is contra-indicated in all patients having a pressure of 20 mm. mercury or over, in the horizontal lateral position. Lumbar puncture in such individuals may cause a foraminal hernia of the posterior cerebellar hemispheres. Any obstruction of the ventricular system in the region of the third ventricle, aqueduct of Sylvius, and the fourth ventricle, such as found in tumors in any of these regions or from outside pressure, will cause a considerable increase in the intracranial pressure. It is therefore essential that careful neurological studies to exclude any of the above possibilities be made before one is justified in suggesting encephalography as a diagnostic measure.

Errors in Technic.—Occasionally one will find a complete absence of filling of the ventricles with air in the encephalogram.

This usually means that the surgical technic or drainage of the cerebrospinal fluid and replacement with air was not adequate, and therefore should be regarded as an error in technic unless one has strong clinical evidence to the contrary. We have noticed that the absence of filling of the ventricles is almost proportional to the experience of the operator. The inexperienced operator is satisfied with much less manipulation of the head than the experienced. If a roentgenogram is made twenty-four hours later, the ventricles may contain air which would exclude a pathologic lesion occluding the foramina of Luschka and Magendie. Some of our conferees have stated that they believed the absence of filling in such cases was due to a collapse of the cortex into the ventricles preventing their filling. We feel that we have proved that this is not the case because of the fact that in advanced cortical atrophy of external hydrocephalus there is no deformation of the ventricles. Another explanation may be that suggested by Bateman who says that he has demonstrated a membrane that is not permeable. If this type of membrane covered the foramina of Luschka or Magendie, the absence of the filling of the ventricles could be explained. There are still other physiologists that do not believe there is a normal opening or foramina such as described by Luschka and Magendie, and when it is found it is produced by trauma. The explanation of filling of the ventricles is possibly explained by the fact that the withdrawal of fluid by the lumbar route causes a rupture of the thin membrane which in turn allows the air to enter the ventricles.

There is still another encephalographic finding which has been attributed to an error in technic and that is the filling of only one lateral ventricle. Except in the presence of strong clinical data and a displacement of the midline structures this is always regarded as error in technic due to insufficient manipulation. A roentgenogram made the next day usually shows a filling of the other ventricle.

Encephalograms should be made in the erect posture within an hour after the introduction of the air, the patient having been kept in the erect posture with the head in the midline.

Otherwise, most peculiar findings will be obtained and errors in diagnosis will be made. The air which is subarachnoid at the time of the introduction is believed by us to go into the subdural space whereupon the convolution markings are lost, therefore we feel that the sooner the roentgenograms are made, the better the result will be.

COMMENTS

Dandy deserves a great deal of credit for the work that he did in introducing the diagnostic methods of ventriculography and encephalography. Ever since they were first described the author of these procedures has been criticized by some and praised by others. The procedures are becoming more popular and even those who criticized Dandy utilize these methods as an aid in diagnosis.

There are others who decry encephalography believing that ventriculography is the procedure of choice and vice versa. It seems to me that the indications and contra-indications for the two procedures are precise and both are essential if we are to obtain the maximum informations for diagnosis. I cannot agree with those who feel that encephalography is a more shocking and distressing procedure for the patient than ventriculography. It has been stated that "any neurologist who can perform a lumbar puncture and who owns a syringe can carry it out." This is true provided the technic described above is adhered to. There is very little mortality associated with encephalography. In an analysis of 1529 cases, Pancoast and Fay report 20 deaths or a mortality of 1.2 per cent, whereas Grant found a mortality of 32 cases or 8.1 per cent in an analysis of 392 cases following ventriculography. In a recent communication Grant states that if the patient was operated within twelve hours after ventriculography, the mortality was as low as in cases in which no ventriculogram was done. Another objection that has been offered against encephalography was that nothing can be done after a diagnosis has been made in the large majority of instances. It seems to me that a large group of patients are continually receiving benefit from the diagnoses made following encephalography. For years insurance companies have been

troubled with a large group of cases, termed *posttraumatic injuries*. Fay in an extensive study of these patients has found sufficient pathology to account for their symptoms, and it is to be hoped that ample provision will be made for their compensation in the future. At least it is now definitely known that these patients are not malingerers. In a number of other cases studied by us, and others, tumors, arachnoiditis, porencephaly, brain abscess, brain atrophy, and thrombosis have been diagnosed. Some of these have been operated and permanently benefited.

The roentgenographic technic of encephalography is much more simple than ventriculography as the patient is more cooperative. Furthermore, we examine more patients for encephalography than for ventriculography and some of these patients have increased intracranial pressure. We have assumed, therefore, that the depressing headache is not a real contra-indication and encephalography is gaining popularity and usefulness.

Considerable disagreement seems to exist among various authors as to the safe limits of intracranial pressure of patients on whom encephalography is planned. Pancoast and Fay state that 20 mm. mercury in the horizontal posture is a safe limit. Grant states 8 to 10 mm. mercury or 150 to 200 mm. H_2O in the horizontal posture is the maximum. Gardner states that he has performed the procedure with safety in the horizontal posture with a pressure of 62 mm. mercury or 815 mm. H_2O. He is doing the procedure routinely in all cases except those that have a posterior fossa lesion.

In cases with increased pressure Fay dehydrates the patient for a few days before the operation until their intracranial pressure is approximately normal, then performs the encephalography. Gardner slowly withdraws enough fluid in the horizontal posture to allow the pressure to drop to within normal limits, then the patient is placed in the erect posture and the procedure is completed.

Another objection that has been offered against encephalography is that the shadows of the air in the subarachnoid spaces are at best indistinct and capable of any interpretation to suit

the needs of the situation. In this connection it is believed that close cooperation of the neurosurgeon and the roentgenologist will obviate this difficulty.

The roentgenologist must become familiar with brain anatomy and be able to discuss intelligently roentgenological findings with the neurologist and neurosurgeon. Neurosurgeons should not attempt to make their own roentgenological diagnosis, for herein lies the danger of interpreting clinical findings into the roentgenograms. If the neurosurgeon could recognize that the best diagnosis can be made only after a careful correlation of the clinical and roentgenological data after consultation, then both the neurosurgeon and the roentgenologist would profit by whatever conclusions are reached.

The advantages of ventriculography are:

1. Completely outlining the ventricular system.

2. Localizing brain lesions such as tumors, brain abscesses, and ventricular blocks from any causes.

The disadvantages of ventriculography are:

1. Two incisions and two trephine openings are required and the brain is punctured twice.

2. Hemorrhage may occur following the piercing of an unsuspected occipital lobe tumor. Experienced neurosurgeons, however, can detect the difference between normal brain and tumor tissue, and should a tumor or hemorrhage be encountered, one could proceed with the operation.

3. The reactions following the introduction of the air. Grant states that this can be obviated by proceeding with the operation if the tumor is localized by the ventriculogram. If the tumor is not localized, repeated ventricular tapping with removal of the air will relieve any increase in the intracranial pressure.

4. The mortality associated with the procedure.

5. Failure to find and drain both ventricles.

6. Failure to give any delineation of the subarachnoid spaces.

The advantages of encephalography are:

1. Procedure is simple and can be used in adults, children, and infants.

2. There is very little mortality.

3. Subarachnoid pathways and ventricular system are visible. One can visualize the brain as a whole.

4. Can demonstrate lesions on the surface such as arachnoiditis and brain atrophy which cannot be demonstrated by ventriculography.

5. Brain tumors, brain abscess, and degenerative lesions without or with slight increased intracranial pressure can be diagnosed and localized.

6. The lesions in cases of epilepsy receiving treatment can be followed.

The disadvantages of encephalography are:

1. It causes severe headache, some nausea, and possibly vomiting.

2. It cannot be used in posterior fossa tumors because of the danger of causing a foraminal hernia.

3. The posterior and inferior horns of the ventricles are not easily drained. If it is desirable to outline these portions of the ventricle it will be necessary to examine the patient in the postures utilized in making ventriculograms.

4. The occasional failure to fill the ventricular system. Both procedures are sometimes necessary on the same patient especially in differentiating between an infra- and supra-tentorial lesion. The neurosurgeon makes a totally different approach on these lesions and an exact diagnosis is essential.

CLINIC OF DR. EDWARD T. CROSSAN

SERVICE DR. A. P. C. ASHHURST

EPISCOPAL HOSPITAL

FRACTURES OF THE TARSAL SCAPHOID AND OF THE OS CALCIS

FRACTURES of the tarsal scaphoid and of the os calcis have been grouped together for presentation in this clinic because (1) there is a similar method of production in both varieties, a fall or jump from a height landing on the feet; (2) the disturbance to the subastragalar joint from either fracture is a potential source of severe pain and prolonged disability, and (3) the common method of treating these fractures by plaster casts alone insures the appearance of the disagreeable symptoms.

In the literature of the past few years there are numerous reports pointing to the need for radical treatment of fractures of the os calcis. In reviewing the os calcis fracture records of this hospital for the decade 1917 to 1927, I found the following facts about the passive method of treatment, viz: (*a*) All bilateral fractures, and the unilateral fractures occurring in patients over sixty years, were permanently disabled; (*b*) the average disability in the other patients was eight months, in one case it was eighteen months, and in another it was two years; (*c*) 80 per cent of the patients were never free of pain after the accident. In spite of the broadcasting of results similar to these, many surgeons still follow a policy of noninterference. That which has been said about os calcis fractures is equally true of scaphoid fractures.

Pain is the theme of the history in all of these untreated cases; it is severe pain, constant pain, and pain aggravated by walking on rough surfaces. Interpretation of the symptoms is easy when you recall the function of the subastragalar joint.

In walking there is a constant need for inversion and eversion of the foot in order to accommodate the foot to uneven surfaces, otherwise there would be frequent strains on the lateral ligaments and perhaps fractures of the malleoli; these motions occur at the subastragalar joint. If the joint lines are distorted by fractures, or if the motion of the joint be limited by periarticular or intra-articular adhesions, any irregularity of the ground, even as slight as a matchstick or a pebble will cause severe pains from the pressure or the stretching and, moreover, walking for more than a few squares cannot be endured. Parenthetically, let it be noted that we follow the teaching of G. G. Davis in considering that the astragaloscaphoid joint is a part of the subastragalar joint.

FRACTURES OF THE OS CALCIS

Case I.—R. D., age twenty-five years, carpenter by occupation. Previous medical history and personal history are not noteworthy.

History of Present Illness.—On October 29, 1929, the elevator in which the patient was riding fell 65 feet, causing the patient to sustain injuries of both feet. He was taken to a hospital in the town where the accident occurred, and an *x*-ray examination showed a fracture of the inferior surface of the left os calcis and a fracture of the body of the right os calcis. He was detained in the hospita. several weeks; the feet were at first elevated and then plaster casts were applied. There was no history of attempted reduction. The patient was admitted to this service on May 1, 1930. Up until a few weeks before admission he had been walking with crutches. At the time of admission he still was unable to walk more than a few squares and had severe pains on walking on rough surfaces.

Examination.—Was essentially negative except for the feet. Feet: Beneath each malleolus there was a definite bony mass, worse on the left side. There were practically no active or passive motions at either subastragalar joint. Gait was of the pedestal type.

Treatment.—Reduction of the deformity in this case was out of the question because of the age of the fracture. It is true that I might have removed the piled-up bone beneath and behind the malleolus as has been advocated by Magnuson, but there was no line of contact between the bony projections, therefore, it was not probable that this was the cause of the symptoms. Subastragalar arthrodesis, the method popularized by Wilson, seemed to offer the means of preventing the traction on the adhesions. Accordingly I ankylosed the right joint on May 9th, and ten days later I did a similar operation on the left side. Though this patient is symptom-free now, it is too early to say that he is permanently free of symptoms. It is my hope that the result will be as good as that obtained in the next case to be shown.

Case II.—G. S., aged sixty-two years, laborer by occupation.

History of Present Illness.—On November 23, 1929, the patient fell 6 feet, landing on both heels with most of the weight on the right side. Soon after the accident the foot became swollen and within a few days the foot and leg became discolored. He was seen by his family physician who diagnosed the condition as a sprain.

I first saw the patient on December 4th. On account of the history of the trauma and because of a fulness beneath the malleolus, I felt sure that the patient had a fracture of the os calcis. An *x*-ray examination (Fig. 596)

Fig. 596.—Case II. G. S. Showing fracture of os calcis.

showed a comminuted fracture of the os calcis, and reduction was advised, but the patient refused to permit even a plaster cast. On December 15th he returned to the hospital and consented to an application of a cast; the cast was removed in six weeks.

On February 27th he was admitted into the hospital. Up until this time he had been unable to walk without crutches, had constant pain in the foot, and the foot was always swollen.

Examination.—Very obese male, with a barrel-shaped chest and emphysematous lungs. The heart sounds were weak, but regular. The condition of the foot has already been noted.

Treatment.—On February 28th, and under spinal anesthesia, I did a subastragalar arthrodesis. In this case, as in the first one, I did not remove the callus nor divide the tendo achillis.

Result.—The convalescence was uneventful except for two fainting attacks, probably cardiac in origin. At the time of this presentation, and for the past four months, the patient has had no swelling, no pain on walking, does not need support, and the arthrodesis is solid.

The Operation of Subastragalar Arthrodesis.—This is an old, or a comparatively old, operation in orthopedics, and has been used for many years as a stabilizing operation for paralytic valgus and varus deformities. The procedure is also comparatively simple. Through a slightly curved incision (Fig. 597) placed between the peroneal tubercle and the tip of the malleolus, the joint is opened and the cartilage from the apposing surfaces of the astragalus and os calcis (Fig. 598) is removed by a gouge.

Fig. 597.—Incision used for subastragalar arthrodesis (Wilson).

In all the subastragalar arthrodeses done on this service, the cartilage of the astragaloscaphoid joint is also removed. This latter procedure in children frequently can be done through the original incision, but in adults it is usually necessary to make a second incision on the dorsum of the foot at the joint level which is located by identifying the scaphoid tubercle on plantar aspect. After the wound is closed a plaster cast is applied for six weeks.

It is the exceptional case that requires only a subastragalar

arthrodesis. In most instances an additional division of the tendo achillis is required because of the usual contracture of the tendon after these fractures. Even in Cases I and II, where the dorsiflexion of the foot was nearly normal, a tenotomy would probably have hastened a restoration to the normal gait, and perhaps would have eliminated the pain on the anterior surface of the ankle about which both of these patients complained for some weeks after they resumed walking. In addition to the

Fig. 598.—Normal foot showing relations of subastragalar joint.

tenotomy, some of these patients need a removal of the piled-up bone (Magnuson's operation) or an osteotomy of the os calcis. The next case is an example where both of the latter procedures should have been combined with the arthrodesis.

Case III.—R. L., aged twenty-seven years. Previous medical and personal histories as obtained at the time of his first admission were unimportant.

History of Present Illness.—On August 9, 1929, the patient stated that he had fallen three and one half stories, sustaining injuries of his back, of his left wrist, and of both feet. He was taken to a near-by hospital where an *x*-ray examination showed no bony injury of the back, but did show a fracture of the lower end of the radius not displaced, and a bilateral fracture of the os calcis. He was detained in the hospital two and one half months; no operations were done.

He was admitted to this hospital on November 13, 1929, and up until the time of admission he had only walked a few steps with the aid of crutches.

Examination.—There was a very marked fulness beneath each external malleolus, a pronounced eversion of both heels, and limitation of dorsiflexion at the ankle to about 100 degrees. The patient stood up with great difficulty, and could not take a step without support. The remainder of the physical examination was essentially negative.

Treatment.—Within three weeks after his admission I had done the arthrodesing operations and tenotomies of the Achilles tendons; I did one side at a time with an interval of ten days between operations.

Progress.—He was discharged from the hospital in the latter part of February, walking without support, but with some pain and with a marked shuffling gait. He returned to me in the early part of March complaining that there was something that slipped on the outer side of each ankle when he walked; he said that for several years previous to the accident this "slipping" had been a common occurrence on the right side. Examination at this

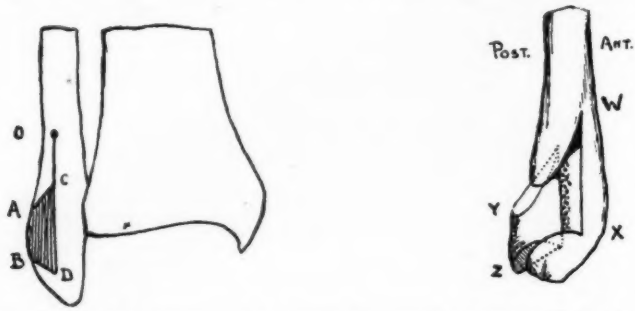


Fig. 599.—Kelly's operation for dislocated peroneal tendons. (R. E. Kelly, Brit. Jour. of Surg., Published by John Wright and Sons, Ltd.)

time showed a dislocation of both peroneal tendons on each side, the tendons being visible over the posterior part of the malleolus and the lower fourth of the fibula.

I had planned to do Kelly's operation (Fig. 599), but I soon found out that the mass of bone behind and below the malleolus had so obliterated the peroneal sulcus that this procedure would be of no avail. Accordingly on March 26, 1930, I made a groove on the posterior aspect of the lower fifth of the fibula and behind the malleolus and fixed the tendons in their new bed.

He was discharged from the hospital in the latter part of May. He had been walking about the hospital for two weeks before discharge, and up until that time there had not been any recurrence of the dislocation of the tendons. At the time of his discharge the gait was markedly shuffling and there was a decided eversion in both heels.

Comment.—The patient was undoubtely improved by the operations. However, and in spite of the patient's history, had

I removed the excess bone around the malleoli at the first operation, I believe that dislocation of the peroneal tendons would have been avoided. Furthermore, I am not sure that this patient is as well as he would have heen if a wedge-shaped osteotomy had been done on the medial aspect of the os calcis to correct the eversion of the heel.

Treatment of Recent Cases.—Subastragalar arthrodesis is valuable in the recent as well as the old fractures of the os calcis. In the recent cases too, the operation should be combined with other procedures that will correct the deformity or minimize its effects.

There are opponents to this form of treatment, and some surgeons report excellent results by reduction alone. Harding reports an average disability of five months for 15 cases treated by his method of closed reduction. Harding's method (Fig. 600)

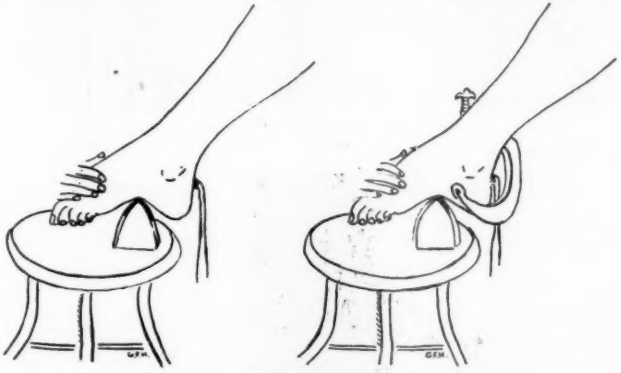


Fig. 600.—Harding's method of closed reduction of fracture of os calcis. (Harding, Jour. of Bone and Joint Surg., p. 721, 1926.)

consists in (*a*) claw hook retraction of the heel without tenotomy of tendo achillis, (*b*) downward traction of the forepart of the foot at the same time and over a wedge, (*c*) pressure by a D clamp over the heel to reduce the broadening of the os calcis, (*d*) cast from toes to midthigh with the foot in plantar flexion.

Quite recently I came across a paper by Berard reporting a case of open reduction with maintenance of the fragments in

Fig. 601.—Case IV. Malunion of fracture of left ankle.

Fig. 602.—Case IV. Fracture of scaphoid.

position with a bone graft and apparently without any tenotomy: for this case Berard reported a disability of three months. I believe that open reduction without the bone graft, but with a tenotomy, is a logical procedure, and if the fracture lines run into the neighboring joint, a subastragalar arthrodesis can be done at the same time.

FRACTURES OF THE TARSAL SCAPHOID

These fractures are uncommon, and usually result from forced plantar flexion of the foot over some object in landing from a fall or a jump. There are two theories of the mechanism: (1) Pressure of the astragalus against the scaphoid; (2) pressure of the middle cuneiform on the inferior aspect of the scaphoid. *x*-Rays usually show a wedge-shaped bone with the bone pushed up above the line of the astragalus. (Compare Fig. 598 with Fig. 601.)

Case IV.—W. E., age thirty-eight years. The previous medical history and personal history are not pertinent to the discussion.

History of the Present Illness.—On July 24, 1929, the patient fell 40 feet, landing on his feet. He was taken to a hospital in the town where the fracture occurred, detained there forty-eight days, and plaster casts applied; no history of any operations or attempted reduction.

He was admitted to this hospital on March 3, 1930, complaining of pains in the right foot, marked swelling, and inability to use left foot. He had been using crutches or a cane ever since he had been discharged from the hospital.

Examination.—General physical examination negative.

Lower extremities: Left: Extreme valgus deformity of left foot. Marked thickening at lower end of tibia. No motion at ankle or subastragalar joints. Foot and leg markedly swollen.

Right: Except for painful inversion of the foot, the examination was negative.

x-Ray Examination.—Malunion fracture of lower end of tibia and fibula, left (Fig. 601); fracture of scaphoid, right (Fig. 602).

Case V.—Wm. K., age thirty years. Lumbar yard foreman.

History of Accident.—On November 28, 1928, he jumped from a box car, landing on the rails. He was treated in a hospital near here for multiple fracture of both feet; an anesthetic was given for reduction and plaster casts applied.

He was admitted to this hospital on February 28, 1929, complaining of severe pains in the left foot, and inability to walk more than a square or so There were no symptoms referable to the right foot.

Examination Lower Extremities.—Right: There was a marked prominence on the dorsum of the foot at the level of Lisfranc's joint; the projection gave to the foot the appearance of a cavus deformity. All motions were normal.

Left: Just distal to the ankle joint on the inner side of the dorsum of the foot there was a small bony projection. No motion at the subastragalar joint. The gait was of the pedestal type.

x-Ray Examination.—(1) Old fracture of all three cuneiforms, left, and (2) old fracture scaphoid, right (Fig. 603).

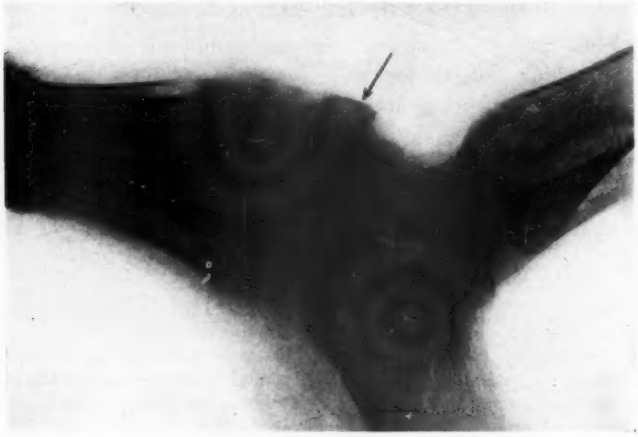


Fig. 603.—Case V. Fracture of scaphoid.

Comment.—It is improbable that any form of closed reduction would be successful in these fractures of the scaphoid. Leriche has reported a successful result by open reduction, and this procedure would seem to be the correct method of treatment. In the cases where open reduction is impossible and in the old cases, removal of the fractured bone is the only means of relieving the symptoms. Functionally at least, the astragaloscaphoid joint is a portion of the subastragalar, as is shown by the histories of Cases IV and V. After removal of the scaphoid bone, which I did on both patients shortly after their admission to the hospital, the symptoms disappeared. In Case V, the patient returned to light work in June, four months after the operation and seven months after the injury. W. E., Case IV, has not yet returned to work on account of the malunion of the fracture

of the ankle, on which reconstruction procedures have been inaugurated.

The removal of the bone seems to be sufficient in these cases. On W. K., Case V, I filled in the gap with a small bone graft; on W. E., Case IV, I did not use any graft; the result in Case V was no better than that of Case IV, and no deformity resulted in Case IV.

CONCLUSIONS

Nearly all cases of fractured os calcis require some form of radical treatment. All cases of compression fracture of the scaphoid demand open reduction.

CLINIC OF DR. ASTLEY P. C. ASHHURST[1]

DR. JOHN W. KLOPP, CLINICAL ASSISTANT

EPISCOPAL HOSPITAL

THREE COMMON SURGICAL DISEASES OF THE RECTUM: HEMORRHOIDS, PROLAPSE OF THE RECTUM IN CHILDREN, AND FISTULA IN ANO

THIS clinic is devoted to a consideration of three of the commonest diseases of the anorectal region, namely, hemorrhoids, fistula in ano, and prolapse of the rectum in children. Many of the following facts, though scarcely original, but rather illustrative of what has been known and taught for years, have been secured from the records of this[2] and a neighboring[3] hospital; and the patients are from the surgical service of Prof. Astley P. C. Ashhurst, except the child with prolapse, who is in charge of Dr. E. G. Alexander. Since the greater proportion of these three common anorectal diseases will fall under the care of practitioners of general medicine, at least during the first, and, what is often forgotten by the operator, the last part of their courses, and not, as might be supposed, to proctologists and surgeons, it is with the family doctor in mind that this study is undertaken.

HEMORRHOIDS

Hemorrhoids or piles have been defined as varicose veins of the rectum and anal region; and by varicose is meant unnatural, permanently dilated, tortuous, and elongated veins.[4] Just what

[1] Clinic before a section of the Fourth Year Class in Surgery, School of Medicine, University of Pennsylvania, held in the operating room of the Episcopal Hospital.

[2] Hospital of the Protestant Episcopal Church.

[3] St. Christopher's Hospital for Children.

[4] Da Costa, John Chalmers: Modern Surgery, W. B. Saunders Co., Philadelphia, 1900, p. 305.

veins become dilated, tortuous, and elongated used to be in dispute, but in recent years it is well established that not all hemorrhoids come from one venous system; those on the inside (*i. e.*, inside the external sphincter, and hence covered with mucous membrane) are related to the inferior (external) hemorrhoidal vein, while those on the outside surrounding the anal orifice *may* contain dilated, elongated, tortuous branches of the skin veins. These points are of little more than academic interest, however, for all three hemorrhoidals have a free anastomosis. Not only is the general circulation represented through the inferior (external) hemorrhoidal via the internal pudic, into which it drains, and through the middle hemorrhoidal via the internal iliac or a branch; but also the portal system through the superior (internal) hemorrhoidals via the inferior mesenterics, into which they empty.[1]

Some authorities believe that occasionally hemorrhoids are encountered which fail to fit the above definition, these being neoplasms, hemangiomata, and not mere varicose dilatations of preformed veins, and point out the curious fact that hemorrhoids in children are apt to belong to this class.[2] Montague,[3, 4] however, vigorously disputes this view, even going so far as to place this in his long list of the popular fallacies concerning hemorrhoids.

These and other considerations are important from the standpoint of etiology, for embedded in loose areolar tissue, these poorly supported, valveless veins are subject to the bottommost hydrostatic pressure of a tall column of blood above, peculiarly liable to stasis and increased pressure from causes both physiologic and pathologic, not only in the general, but in the portal system as well. The fact that the incidence of this disease is very much smaller in the lower animals suggests that it is part of the exacting debt man has had to pay for the upright

[1] Ashhurst, Astley P. C.: Surgery, Principles and Practice, Lea & Febiger, Philadelphia, 1920, p. 961.

[2] Johnson, A. B.: Surgical Diagnosis, D. Appleton & Co., New York and London, 1909, vol. ii, p. 244.

[3] Montague, J. F.: Med. Jour. and Rec., 1926, cxxiii, 445.

[4] Ibid., p. 487.

posture. Likewise, the sedentary habits of civilized races make them more liable than primitive ones. According to the statistics of this general surgical clinic, it is more frequent in men than in women (Table 1), but it is probable that experience in a gynecological clinic might lead one to the opposite conclusion. It occurs for the most part in adult life, being rare in children. The carelessly made diagnosis, "hemorrhoids" in children under three years of age is usually prolapse or polyp.

TABLE 1

958 cases of hemorrhoids treated by operation at the Episcopal Hospital, 1905–1928, inclusive, tabulated according to diagnosis and sex.

Diagnosis.	Number of females.	Number of males.	Total males and females.
Internal hemorrhoids	150	522	672
External hemorrhoids	33	157	190
Intero-external hemorrhoids	13	83	96
Total, all kinds of hemorrhoids	196	762	958

For purposes of study, hemorrhoids are classified as internal, external, or intero-external, according to their relation to the external sphincter. The internal variety is most common as shown in Table 1. They may also be designated as inflamed, thrombosed, ulcerated, and gangrenous, terms which are self-explanatory.

The most characteristic symptom of hemorrhoids is bleeding, although this is confined to the internal variety. It occurs during or after defecation. Its bright red color and distribution only on the surface of the stool serve to distinguish such blood from that escaping higher in the intestinal canal, in which case it is more likely to be dark brown and more intimately mixed with the feces. Cases of hemorrhoidal bleeding as vicarious menstruation have been recorded as curiosities.[1] Internal hemorrhoids may cause no discomfort unless during attacks of constipation or diarrhea they may become swollen causing a constant sense of fulness and varying degrees of pain, itching, paresthesia, and throbbing of the perineum, and may even prolapse. When inflammation sets in, the pain may become most

[1] Auerbach, L.: Arch. f. Verdauungskr., 1926, xxxviii, 15.

intense and the patient quite disabled as a consequence of this or something more serious. For some curious reason, the suffering thus entailed is usually classed, like seasickness, as something quite humorous, but indeed very serious consequences have been noted.[1] For example, sudden large profuse hemorrhage might exsanguinate the patient, or, what is often just as bad, though less spectacular, insidious, repeated small hemorrhages may give rise to a profound grade of secondary anemia.[2] Gangrene of the rectum following long-standing prolapsing hemorrhoids is sometimes seen,[3] and intestinal obstruction has been noted.

The treatment, of course, varies with the pathologic condition found. Mild cases demand little more than regulation of the diet, and of the bowels through gently acting laxatives if necessary. Removable causes should be sought, bearing in mind the discussion about etiology. Prolapsed piles, if they fail to slip back themselves, must be replaced, and such cases demand scrupulous attention to cleanliness, irrigations being of value here. Astringent ointments or suppositories are useful as local applications, but inflamed hemorrhoids usually require more careful attention. In case of inflammation, the patient should rest in bed with the hips elevated, and apply ice-bags, or dry heat to the perineum. If this fails to relieve after a reasonable trial, the doctor can easily do so by incising the thrombosed piles and turning out the clots. Anything more radical demands hospital care according to modern standards.

The operations usually employed for hemorrhoids are ligation and excision, clamp and cautery, injection, and excision of the pile-bearing area of the rectal mucosa (Whitehead's operation). For the average operator, the ligation method is the easiest and gives the best results according to the experience of Dr. E. T. Crossan,[4] who, as director of our end-result clinic, is in the same favorable position as the family doctor to observe

[1] Montague, J. F.: Amer. Jour. Surg., 1925, xxxix, 67.
[2] Saphir, J. F.: Med. Jour. and Rec., 1928, cxxviii, 508.
[3] Milligan, E. T. C.: Proc. Roy. Soc. Med., London, 1928, xxi, 1443.
[4] Crossan, Edward T.: Personal communication.

patients after the surgeons have finished with them. Accordingly, this patient will be operated upon by that method:

Case I.—E. K., a white schoolboy, ten years of age, gives a history of chronic constipation, with moderate straining at stool. For the past four months he has been suffering attacks of pain on defecation, lasting for a day or two, but causing relatively little trouble. Four days ago the present attack commenced, but it differed from previous ones in that it was accompanied by slight bleeding at the end of defecation. Two days ago he passed an amount of blood which frightened his parents, and they brought him here on the advice of their physician.

You will notice that I employ the lithotomy position, and that the patient is anesthetized with nitrous oxide-oxygen. In adults I much prefer to use spinal anesthesia, although some operators employ local or sacral,[1] almost routinely. After having cleansed the field with soap, water, and alcohol, and draped the patient, I will dilate the sphincter carefully, inserting one well-lubricated index finger at first, and then both later, as the first makes more room, finally separating the two gently in various diameters of the anus. If my wrists are crossed, this stretching process is facilitated and is under better control. Now, as my hands are held back to back, with the index fingers in the rectum parallel to each other, and separated about 1 cm., they serve as a proctoscope, and a view of the anal canal and lower rectum is obtained, comparable to that given by more or less elaborate instruments.[2] Some surgeons stretch the sphincter till their fingers bump the rami, with the object of paralyzing the muscle to prevent postoperative spasm and pain, but I believe this is poor practice, as it is unnecessary, as far as relieving pain is concerned, and may do permanent damage to the sphincter. Other authorities do not dilate at all, except, of course, in order to get the internal piles down. But the average operator will do better if he dilates the sphincter at least moderately. You will note now that this boy's rectum and anus are empty and clean, both normal findings. No feces come down from above because the patient has been prepared by emptying his colon with mild laxatives yesterday, and an enema or two this morning. Drastic measures in this respect are not to be recommended. This dark-red "lump," at five o'clock, on the anal circumference, lies just on the edge of the mucocutaneous junction, so that it is partly inside the sphincter and partly outside. Notice that it bleeds at the slightest touch. It is covered by red mucous membrane on its internal bleeding portion, and by skin out here beyond the anal margin, an intero-external hemorrhoid. Two smaller ones wholly internal, which are not so prone to bleed, lie on the right here at about seven and ten o'clock. These three sites are constant for primary piles. Secondary piles, not present in this boy, are never more than four in number.[3] When they

[1] Syms, P.: Surg., Gynec., and Obstet., 1924, xxxix, 349.

[2] Da Costa, J. C.: Modern Surgery, W. B. Saunders Co., Philadelphia, 1900, p. 878.

[3] Miles, quoted by Ashhurst, Astley P. C.: Surgery, Principles and Practice, Lea & Febiger, Philadelphia, 1920, p. 961.

are present, the operator will do well to leave a small island of mucous membrane between each to prevent cicatricial stenosis. I now grasp each of the three separately with Allis forceps (an ordinary hemostat would tear or slip off), before proceeding further, for if I should grasp only one at a time, completing the operation on that before going to the second, then I might dislodge ligatures as I searched for the next. Selecting the lowermost, *i. e.*, nearest the floor, first, in order to keep blood out of the field of the other two higher up, I will first cut a groove with curved scissors through the skin covering the margin of the pile, taking care not to make this groove too far centrifugal to the mucocutaneous junction, lest a contracture result. As cutting the groove severs cutaneous nerves, it alleviates much of the postoperative pain, and, furthermore, it serves to anchor the transfixing ligature I am about to apply. I now transfix the center of the base of the pile with a large curved (either round, or skin-cutting) needle, carrying a very heavy double-silk ligature, with both ends of equal length. I carry the needle from above (cephalad) downward, in order to estimate more accurately just how much needs to be tied off, bringing it out exactly in the groove just made. Now, as the needle is cut away, leaving four loose ends of ligature, I strangulate the pile by tying the appropriate two very firmly below the hemorrhoid in this groove, and the opposite pair above it, using the Allis forceps as a tractor on the pile. It is well to relax this traction just as the ligature is pulled tight, otherwise it might slip later. The part distal to the ligature seems to be of sufficient bulk to excise, but note as I do so, that I preserve enough stump to hold the ligatures, and that I do not cut these short till I am sure the field is dry. Some operators tie the two upper strings to the two lower ones at this stage, hoping thereby to squeeze a crescentic scar into a linear one of smaller size. The remaining two hemorrhoids give me less concern as they are wholly internal, and, therefore, do not require my grooving their margins before ligating and excising. Iodoform powder dusted on the wound is somewhat analgesic and antiseptic. I will use it before applying this sterile gauze pad to the perineum. I might have inserted a small soft-rubber cather to allow gas to escape, but larger tubes or rectal plugs are to be condemned. I fail to see how morphine suppositories can be employed rationally, although occasionally I insert one at this stage.

The boy will be placed on his back in bed in the "hips high" position, maintained by placing pillows under his thighs, and, if he needs it for pain, morphine will be given.[1] It is not wise to use the patient's ability to stand pain as a guide in giving morphine, but to use it freely for a day or two on the slightest provocation. A physician friend once advised me that this would be his policy in all minor surgical cases after he recovered from the experience of a tonsillectomy on himself. The administration of opium or other constipating drugs to "tie up the bowels" is utterly useless, except in young children, for a simple explanation to the patient that it would be better for him not to open his bowels for a few days, will always produce the desired result. If the bowels do not move spontaneously on the fourth day, a moderate dose of castor oil may be given, and thereafter the diet,

[1] Montague, J. F.: Jour. Amer. Med. Assn., 1925, lxxxiv, 1039.

restricted up till then, liberalized. Enemas should be avoided. The dressing is changed daily, the parts being kept dry, and for the succeeding two weeks, the patient must pay close attention to local cleanliness. He may be allowed to get on the tenth to twelfth day, and, as his family physician takes charge of him later, he should be appraised of the history of chronic constipation.

The remaining types of operations for hemorrhoids can be dispensed with briefly. The clamp and cautery method requires preliminary grooving of the skin and other technic similar to the ligation method up to the point of transfixing the strangulating ligature. Instead, the hemorrhoid is crushed at its base with a flat pile clamp applied radially to each in succession, and the projecting portion of hemorrhoid burned off, not too closely, with the actual cautery at a cherry red (not white) heat. Although the skin surface of such clamps is covered by a substance having poor heat conductivity such as a lead or ivory face, it is safest to insert wet gauze between it and the skin before using the cautery to prevent blistering. Care must be exercised in opening the jaws of this clamp to avoid tearing the eschar apart.

The injection of hemorrhoids is surrounded in popular professional circles by an unsavory atmosphere of charlatanism, but is beginning lately to occupy its rightful dignified and ethical position as a method of scientific value, although it is not applicable to all kinds of hemorrhoids. Experience with it in this clinic is so limited as to make any further observations presumptuous.

The Whitehead excision of a cylinder of anal and rectal mucosa in the pile-bearing area, with suture of the upper cuff to the mucocutaneous circumference of the anus is becoming less and less popular as surgeons continue to encounter the characteristic sequela, a deformity of the rectum with cicatricial stenosis. Case II illustrates this:

Case II.—Mrs. K., white, age sixty years, was operated upon in June, 1921, by a very competent surgeon. The operation consisted in a cervical and perineal repair, with the Whitehead operation for extensive prolapsing hemorrhoids. Her convalescence was uneventful, but by the time a year had elapsed, the patient began to find herself constipated more and more. In another year or two she noticed the typical "lead-pencil stool" of rectal

stenosis, and her constipation by that time had become almost absolute. In May, 1928 it was necessary for her to return to her surgeon, who found at the site of his operation seven years previously, a scar so firm and contracted as to make the subsequent dilatation under gas a formidable procedure. Since then the patient has been passing rectal dilators herself at home, keeping herself fairly comfortable. Smith[1] reports good results in these scarred cases by using a cautery.

PROLAPSE OF THE RECTUM IN CHILDREN

Before operating upon Case III, a child with prolapse of the rectum, I shall consider a few points about this disease in children. When only the mucous membrane of the anus protrudes, this is called "anal prolapse," and all stages between this and prolapse of the entire colon to the ileocecal valve are possible. If the prolapse cannot be pushed back, the probability is that the muscular coats as well are protruding, and the term "procidentia" applies.

Anatomical peculiarities of childhood have been used to account for the greater incidence of this disease among young children. Thus, the sacrum and coccyx are nearly vertical, and so is the rectum on account of the small amount of tilting of the pelvis at this age; and the mesosigmoid is longer in children. It is significant also that most cases occur just at the time when the child is making a transition to the upright posture, between the first and third years (Table 2). Furthermore, weak pelvic support is prone to occur in the wasting diseases of infancy, and intestinal disturbances are rampant in this same age group—so that we have a combination of factors to account for its age incidence.

Operations for rectal prolapse are legion. They may be classified according to the following outline[2]:

1. Excision of the pathologic part.
   (*a*) In whole.
   (*b*) In part.
2. Suspension of bowel within the abdomen.
   (*a*) Without obliteration of the culdesac.
   (*b*) With obliteration of the culdesac.

[1] Smith, D.: Jour. Amer. Med. Assn., 1928, xci, 879.
[2] Maes, U., and Rives, J. D.: Surg., Gynec., and Obst., 1926, xlii, 594.

3. Fixation of the rectum to sacrum and coccyx.
   (*a*) Usually with shortening of the external sphincter.
   *(*b*) Without shortening of the external sphincter.
4. Shortening or narrowing the gut by:
   (*a*) Plication.
   (*b*) Wedge-shaped excision.
   (*c*) Excision of mucous membrane.
   *(*d*) Cautery.
5. Plastic operation on pelvic supports.

*6. Perianal and perirectal injection of irritant chemicals.

Only those marked "*" are applicable to the treatment of small children since the introduction of D'Espine's simple alcohol injection has rendered the other operations obsolete.[1] Case III will illustrate this operation.

Case III.—M. B., age three years, is a white male, whose mother brought him to the dispensary last winter, complaining of a lump in his left scrotum. The examining surgeon diagnosed this "hydrocele, left," and noted that the child had a small (0.5 cm. diameter) umbilical hernia and a redundant prepuce. Operation for all three conditions was advised, but as the child had a chronic cough, it was deemed wiser to wait till warm weather. Two days ago his mother, who had been on the verge of bringing him back for operation in accordance with this advice, noticed that his "rectum came down," and this event terminated her procrastination. Examination at that time revealed a prolapse consisting of mucous membrane of the anus and lower rectum, which protruded 2 or 3 cm. This bled easily, but was readily reduced in the usual manner by first lubricating with sterile olive oil, and then pressing steadily on the apex with one hand while using the bunched fingertips of the other around its circumference as a guide. It has been held in place since by keeping the child's buttocks strapped tightly together with a broad strip of adhesive plaster. He has had the usual preoperative preparation of a *mild* laxative (not a purge), and a *gentle* cleansing enema. Ether anesthesia is best for so small a child.

He is held in the lithotomy position while I cleanse the field with soap, water, and alcohol, and drape him. Now, using my left index finger in his rectum as a guide, I take this syringe containing 2 cc. of absolute alcohol in the other hand and, using a long needle of about 23 gauge, inject it perirectally. Notice that I insert the needle at right angles to the skin about 0.5 cm. to the left of the anal margin at a point just posterior to its horizontal diameter. In a child of this size the alcohol is injected at a depth of about 4 cm. Care must be exercised not to get too close to the rectal wall with the point of the needle, for infection might result, as indeed was the case in one of the series I will discuss later (Table 2, Case No. 25545).

[1] Alexander, E. G.: Ann. of Surg., 1922, lxxvi, 496.

TABLE 2

Summary of Cases of Prolapsed Rectum, St. Christopher's Hospital for Children, 1921 to 1929, Inclusive

Case number.	Sex.	Age.	Treatment.	Etiology.	Duration.	Result.
19672	F.	33 months.	D'Espine's alchool injection.	Unknown.	2 to 3 months.	Recurrence at first bowel movement, none since.
19661	F.	5 years.	D'Espine's alcohol injection.	Polyp.	4 months.	Recurrence during bowel movement on fifth day. Strapped. None since.
19679	M.	2 years.	D'Espine's alcohol injection.	Diarrhea.	3 weeks.	Recurrence on first bowel movement, fourth day. Strapped. None since.
19745	M.	3 years.	Treated wasting illness. Strapped buttocks.	Wasting illness.	4 months.	Cured.
19792	M.	4 years.	D'Espine's alcohol injection.	Bronchopneumonia with bad cough, 1 year ago?	Few days.	Cured.
19767	M.	22 months.	D'Espine's alcohol injection.	Phimosis, severe.	1 week.	Cured.
19703	M.	5 years.	D'Espine's alcohol injection.	Hernia, phimosis, whooping cough.	?	Cured.
19779	M.	2½ years.	D'Espine's alcohol injection.	Unknown.	1 week.	Cured.
19814	F.	6 years.	D'Espine's alcohol injection.	Unknown.	1 year.	Recurred in 1 month. Repeated. Cured.
19986	F.	3½ years.	D'Espine's alcohol injection.	Constipation.	10 days.	Cured.
20875	M.	3 years.	D'Espine's alcohol injection.	Unknown.	1 week.	Cured.
20876	M.	5 years.	D'Espine's alcohol injection.	Father and brother had prolapse during childhood.	2 years.	Recurrence 9 days later. Parents removed against advice.
21052	M.	4 years.	D'Espine's alcohol injection.	Severe diarrhea. Bronchitis.	1 week.	Recurrence 18 days later. Strapped, cured.
21603	M.	3 years.	D'Espine's alcohol injection.	Bronchitis. Poor nutrition.	3 months.	Cured.
23010	F.	3 years.	D'Espine's alcohol injection.	Bronchitis.	6 weeks.	Cured.

23217	M.	4 years.	D'Espine's alcohol injection.	Diarrhea.	3 days.	Cured.
24293	M.	4 years.	D'Espine's alcohol injection.	Diarrhea.	2 days.	Cured.
24425	F.	2 years.	D'Espine's alcohol injection.	Unknown.	2 weeks.	Cured.
25413	M.	2 years.	D'Espine's alcohol injection.	Hypospadias?	1½ months.	Cured.
25545	M.	19 months.	D'Espine's alcohol injection.	Unknown.	1 month.	Perianal abscess 9 days later. Cured.
25795	F.	2 years.	D'Espine's alcohol injection.	Unknown.	1 year.	Cured.
26223	F.	3 years.	D'Espine's alcohol injection.	Diarrhea.	1 week.	Cured.
26230	F.	3 years.	Strapped.	Diarrhea.	6 days.	Cured.
28205	M.	23 months.	D'Espine's alcohol injection.	Unknown.	3 weeks.	Cured.
28940	F.	4 years.	D'Espine's alcohol injection.	Cough. Constipation.	1 month.	?
30059	M.	2 years.	D'Espine's alcohol injection.	Occurred in hospital following cervical adenitis operation.	2 days.	Cured.
30256	F.	23 months.	D'Espine's alcohol injection.	Unknown.	4 days.	Cured.
31435	M.	2 years.	D'Espine's alcohol injection.	Bronchopneumonia. 1 year ago.	6 days.	Cured.

Two cc. are injected in a similar manner on the left side, but before doing this, I shall first change my gloves, and use the right index finger as a guide in the rectum instead of the left. Collodion seals are scarcely necessary, but the buttocks must be strapped together. This child will now have his hydrocele and hernia repaired, and will be circumcised. It is good practice to circumcise all boys routinely following rectal prolapse operations, just as it is in herniorrhaphies in children.

This child will be kept in bed for about ten days, with his buttocks strapped together. For a few days he will be given a constipating diet, and appropriate doses of paregoric, and on the fourth day a dose of castor oil, and a more liberal diet. For two or three weeks this strapping must be renewed after each defecation, which had better be allowed only while the child lies on his side.

If the prolapse recurs at the time of the first few bowel movements following the injection, there need be no cause for alarm, as simple replacement and strapping usually suffices to cure, but once in a while a second injection must be given; this rarely fails.

Table 2 is a summary of 26 rectal prolapse cases treated by the D'Espine method, and two by strapping, on the service of Dr. E. G. Alexander, who reported some of them in 1922.

Of the 28 cases, 17 were males and 11 females. The approximate average age was a little over three years. All were cured except possibly one, whose parents removed him against our advice, when the prolapse recurred on the ninth day (Case No. 20876). Four others recurred shortly after operation, but were cured by simple strapping. One recurred in a month, but was cured by repeating the injection. Only one complication occurred, that being a perianal abscess probably from faulty technic, but this child was cured also. This operation has extreme simplicity, almost 100 per cent success even in bad cases, and freedom from complications to recommend it as the operation of choice in prolapse of the rectum in children, although there are other simple, "bloodless" operations of some merit,[1] and some operators use chemical irritants other than alcohol.[2, 3] Rainey[4] advises conservative treatment by strapping, rest in bed, and hygienic care, resorting to operative measures only

[1] Heald, C. L.: Surg., Gynec., and Obst., 1926, xlii, 840.
[2] MacEwen, J. A. C.: Brit. Med. Jour., 1928, I, 633.
[3] Fansler, W. A.: Jour. Lancet, 1926, xlvi, 374.
[4] Rainey, W. R.: Illinois Med. Jour., 1926, I, 345.

when these fail. Since the alcohol injection is so simple, it would seem to supplant even such methods which have their time-consuming fault as powerful argument against them in these days of the excess cost of medical care.

The explanation for the mechanism of cure in alcohol injection has been checked by autopsy findings.[1] Postmortem dissection reveals a productive inflammation followed by proliferation of connective tissue in the space between rectum and lower pelvic floor.

FISTULA IN ANO

Fistula in ano is usually secondary to an ischiorectal abscess, or one of the other kinds of abscesses occurring around the rectum and anus, but may be primary. All fistulas about the anus are not *fistulae in ano*, for a few may come from carious parts of the neighboring skeleton, a peri-urethral abscess, or a pilonidal sinus. Treatment directed against a fistula fails to cure such cases. Some are undoubtedly tuberculous,[2] though just what proportion is doubtful, judging by publication of widely variable results in the literature[3]; and a few are syphilitic. Of the 443 fistulas operated upon in the Episcopal Hospital from 1905 to 1928, inclusive, 369 were in males, and only 74 in females. Ten of the men were suffering from proved pulmonary tuberculosis, as were 3 of the women. One each of syphilis, diabetes mellitus, psoriasis, and tuberculosis of the rectum occurred in this same series. Of 297 males and 71 females operated upon for ischiorectal abscess during the same span of years, 16 males and 2 females later developed fistula. Four males and 2 females with ischiorectal abscess also had proved pulmonary tuberculosis, and another man had a tuberculous hip. But of 947 cases of proved pulmonary tuberculosis, only 3 males and 1 female came to operation for fistula in ano.

If the fistula is open at both ends, one within the bowel, and the other outside on the skin, it is called complete. If

[1] Brown, H., and Drake, T. G. H.: Arch. Pediat., 1924, xli, 716.

[2] Colgan, R. C.: Inter. Clin., J. B. Lippincott, Philadelphia, 1930, vol. 1, Series 40, p. 43.

[3] Fansler, W. A.: Jour. Amer. Med. Assn., 1925, lxxxv, 671.

open at one end only, it is called blind—either blind *internal* or blind *external*, according to the location of the orifice inside or outside. Sometimes there are multiple openings from various ramifications of a complicated fistula, which may partly encircle the circumference of the anus in horseshoe form; or several independent fistula may be present.

Fistulas are likewise classified according to their course with reference to anatomical structures, corresponding to the types of abscesses from which they are derived, as: (1) Perianal (between skin or mucous membrane and external sphincter), (2) ischiorectal (between skin and levator ani), often blind external, but often opening between the sphincters or rarely above the internal, and, (3) fistulas arising above the levator.

Incomplete fistulas may cause very trivial symptoms as long as their mouths remain open, but are annoying from the continual irritating discharge. When they fail to drain, however, they are apt to cause pain, tenderness, and throbbing. Blind internal fistula patients suffer from intermittent attacks of pain, with subsequent passage of pus and blood as the dammed-up pus is discharged into the bowel. Complete fistulas cause more trouble as they permit leakage of feces and gas.

The opening is often difficult to demonstrate, a careful search among the anal creases and behind tabs of skin often being necessary in external cases. If this fails, sometimes the finger in the rectum can squeeze out some telltale mucus, from within, or can feel the direction which the fibrous tract takes. Often the tract opens through a papilla, which, in tuberculous cases, is apt to be surrounded by typical "apple jelly nodules."

Treatment consists in laying bare the fistulous tract, and excising or destroying the pyogenic membrane which may or may not be lined with epithelium. Prompt incision of an abscess of this region in a radial direction close to the anus will sometimes prevent the formation of a fistula.

Case IV.—A white male, age thirty-four years, had a "sore near his rectum," several months ago. This broke like a boil after a few days, with relief of pain, but since then there has been a continuous discharge of irritating moisture from the region near the anus, and this causes him to seek relief.

The patient is under a spinal anesthetic in the lithotomy position, and has been cleaned and draped, and his sphincter dilated. His preparation was similar to that for the preceding cases. A tiny pink spot like a small pimple is seen here just outside the anus, at about four o'clock. With my left index finger within the rectum as a guide, I can pass a fine probe through a hole in the summit of that "pimple," and along a tract which passes radially toward the anal wall, terminating blindly at a point just beneath the mucous membrane between the two sphincters. This, then, is a blind external fistula of common type. Substituting a grooved director for the probe, I can now puncture through the blind end where it is nearest the mucous membrane, converting this blind external fistula into a complete one of ischiorectal type. All tissues between the director and the skin I now sever with a scalpel, thereby dividing the external sphincter at right angles to the direction of its fibers (an important detail), and exposing a tough trough of fibrous tissue. I excise this with scissors, and close the resulting wound with about four interrupted sutures of silkworm-gut, passed to its depths, to insure obliteration of dead spaces; and finally dress the wound with sterile gauze.

I might have scraped the tract away with a curet, but this one is so tough that the scissors were more satisfactory. Some operators would criticize my attempting to use primary suture in such a case; they prefer to allow the wound to heal slowly from the bottom by granulation. Not all attempts at primary closure succeed, but most do. The advantages of this are obvious, as there is a better cosmetic result, shorter convalescence, less skilled convalescent care necessary, and less theoretical danger of malignancy developing in a chronically irritated scar.[1, 2] Fortunately, this case presented but one tract. If I failed to excise all branches of a ramifying fistula, there would be recurrence. Another common cause of failure is neglect in excising overhanging skin edges. Horseshoe fistulas should be cut in two stages, in order to avoid dividing the sphincter at more than one place.

This man's wound will be dressed daily, and his sutures removed in about ten days, after which he may go home. The after-care is similar to that given hemorrhoid cases. It demands regulation of the bowels by means of diet and other measures administered under the supervision of the family doctor.

SUMMARY

A case of hemorrhoids is used to illustrate the operative technic of a simple method of hemorrhoidectomy commonly employed by average surgeons. This is discussed from the standpoint of anatomy, etiology, and treatment before and after operation. The Whitehead operation is qualifiedly condemned because of the high incidence of postoperative cicatricial stenosis, an example of which is presented.

[1] Fitchet, S. M.: New England Jour. Med., 1928, cxcix, 766.
[2] Pennington, J. R.: Surg. Clin. N. Amer., 1925, v, 923.

The experience of a small children's hospital with respect to the alcohol injection treatment of prolapse of the rectum is then summarized, and a child operated upon to demonstrate the method.

Finally a patient with fistula in ano is operated upon by a simple method, with primary closure of the wound. In the discussion of etiology, statistics are invoked to show the undoubted relation between tuberculosis and fistula.

CLINIC OF DR. THOMAS J. RYAN

MISERICORDIA HOSPITAL

ACUTE SUPPURATIVE OSTEOMYELITIS

THE case which I wish to present to you this morning is a young girl, twelve years of age, complaining of pain, redness, and swelling in the left leg extending from the knee to the ankle, with maximum tenderness over the lower portion of the tibia. Her temperature, as you will see, is 103 degrees, her pulse 140, and her respirations 26. Her white blood count is 21,000, hemoglobin 80 per cent, and red blood count 3,900,000. This pain began one week ago in the lower portion of the leg and has gradually increased with the swelling and redness until it has attained the size which it is today.

Her past medical history does not elicit any trauma to explain its occurrence and her health has always been good. She has not suffered from any acute infectious disease within the past year and does not give any history which might suggest the causative factor for the production of this condition.

Her family history is negative.

From the clinical findings we feel justified in making the diagnosis of an acute suppurative osteomyelitis and the treatment will be thorough incision and drainage of this infection. As I make my incision over the anterior surface of the tibia, you will note that a large quantity of pus escapes and the periosteum is stripped from the bone throughout its whole extent. The pus is thick, creamy, and contains a few small blood clots. I will take a culture from the pus and feel that the laboratory will report Staphylococcus pyogenes aureus. Why do I suspect this organism? First, because it is so frequently found in foci of infection throughout the body, the tonsils, teeth, in-

fected superficial wounds, furunculosis, acne, pharyngitis, sinusitis, bronchitis, pyelitis, etc.; secondly, it has a tendency to clump while circulating in the blood stream and become lodged in terminal vessels, and, finally, it uses the blood stream as a medium for circulation rather than growth, as does the streptococcus. General blood infection is, therefore, more frequent when streptococcus is the causative agent in the production of the osteomyelitis.

What is the significance of the elevated and ruptured periosteum? This means that the infection has made its way from the medullary cavity through the cortical canals and spread along the outer surface of the cortex under the periosteum. The periosteum was originally elevated, but with the rapid increase in tension from the spreading infection, it ruptured and the inflammatory process has spread to the surrounding tissues. This is nature's manner of relieving the medullary canal and suggests to us our plan of treatment. This elevation and rupture of the periosteum also interferes with the blood supply to the cortex and will be an important factor in the formation of the sequestrum and the production of new bone. The *x*-ray plate which I am showing you does not show any disease within the bone and does not even show any elevation of the periosteum so that this laboratory aid does not assist us in making our diagnosis. It is too early for rarefaction to be shown in the bone and the rupture of the periosteum explains the absence of this shadow.

A blood culture has been taken but it is too early to give you a report upon this. I will have repeated blood examinations made during the convalescent period because I appreciate that these organisms enter the blood stream in an intermittent manner.

As I examine the bone throughout its whole extent I cannot find any evidence of necrosis except a small area of softening near the lower metaphysis. I will, therefore, remove this bone and you note that upon opening the medullary canal there is a small amount of pus escaping. I will not continue any further with this operative procedure except to hold the wound open with iodoform gauze and observe the progress of this patient

from day to day. If I noticed that her temperature continues to approach normal and her pulse decreases along with a drop in her leukocyte count, I will continue to follow a conservative plan by daily dressing of the wound and supportive treatment in the form of high carbohydrate diet, fresh air, sunlight, and a

Fig. 604.

tonic. I will have further *x*-ray studies made, watching the progress of the disease in the bone, and be guided by her temperature, pulse, and white blood cells as to any further operative procedure. This osteomyelitic process will gradually localize itself and produce a sequestrum which can be removed without too much destruction to healthy bone.

It requires eight to ten weeks for nature to produce a sequestrum. Shall I then remove the sequestrum? I will be guided by the extent of new bone formation and wait until the *x*-ray shows a good supportive structure of new bone. This period of time may be four months or it may be six or eight months. Always remember that it is as important to retain the configuration and growth of the leg as it is to remove the diseased process. What will I do if the sequestrum forms, but the involucrum is not produced? I will transplant the fibula with its upper epiphysial line to the tibia and it will hypertrophy sufficiently to bear the weight required of it.

Some time ago it was the custom to open the entire length of the medullary canal, curet the cavity, and drain. However, it has been found that these patients continue with persisting sinuses for a long period of time and require secondary operations. The period of disability and discharging sinuses can be reduced by allowing nature to produce its own sequestrum which can easily be removed. The treatment therefore will be directed to accomplish good drainage and to institute that drainage in such a manner that the best end-result will be obtained in the shortest space of time.

The tibia develops from an upper and lower epiphysial line, the lower one being the more active. That portion of the diaphysis which is associated with the epiphyseal line is known as the metaphysis. Between the metaphysis and the epiphysis is a cartilaginous plate in which there are numerous rapidly dividing cells which are productive of new bone formation. This cartilage should be protected in this operation in order to prevent any hindrance with the growth of bone and the incision should be directed with the utmost care to prevent any involvement of the ankle joint. The blood supply of the tibia enters the bone at an angle about its center through the nutrient artery which divides into a superior and inferior branch, supplying all of the medullary canal. Numerous small subdivisions of these main branches perforate the cortex and traverse the bone through the haversian canals. The bone also receives a blood supply from perforating branches of the periosteum. This blood supply

finally terminates at the metaphysis in wide capillary loops. These wide capillary loops produce a decrease in the blood current and a generous blood supply is furnished to this portion of the bone. Due to the clumping of the staphylococcus and its intermittent invasion of the blood stream this portion of bone offers a very good medium for the development of the infection,

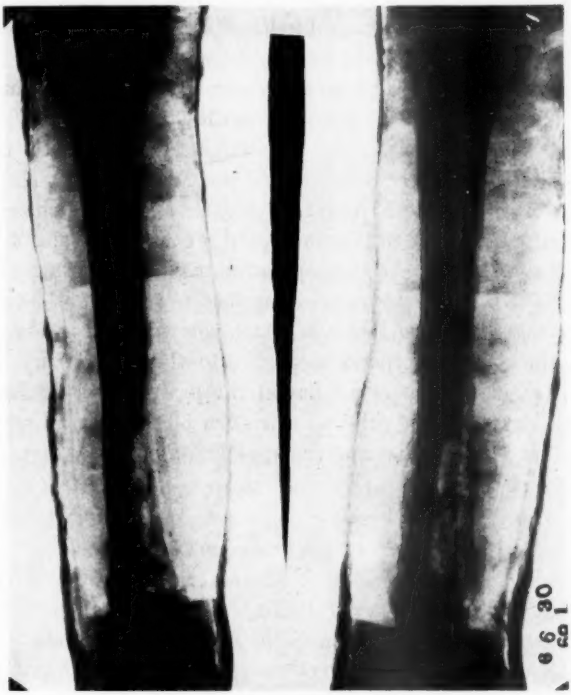


Fig. 605.

so that most of these fulminating cases of suppurative osteomyelitis will be found in young growing patients. In conclusion, with regard to this case, I want to emphasize the importance of carefully studying the case for foci of infection which will account for the production of the disease. Careful blood studies should be made during the period of convalescence to determine

if any intermittent invasions of the blood stream are taking place from the tibia in conjunction with the original focus. All foci of infection should be removed, the general physical condition of the patient should be kept as high as possible, and when a sequestrum has formed with good evidence of new bone formation appearing, the sequestrum should be removed.

The care of this case will continue over a long period of time and will be watched for any further development of osteomyelitis in other portions of the body.

Progress Notes.—The temperature returned to normal in eight days and white blood count was 10,000. Repeated blood cultures were negative. The Wassermann reaction was negative. The tonsils were diseased and were removed. *x*-Ray examination of the teeth revealed an abscessed root which was extracted. Bacteriological examination of the pus revealed staphylococcus. Three weeks after operation a piece of necrotic bone was removed. A plaster cast was applied to the leg and an *x*-ray picture taken through this cast which you will note in Fig. 605, shows the diseased process localizing to the lower half of the tibia. One month after admission the patient was discharged from the hospital and advised to return in three or four weeks for further *x*-ray studies and the application of a new cast.

CLINIC OF DRS. L. KRAEER FERGUSON AND JOHN PAUL NORTH

FROM THE SURGICAL SERVICES OF DR. E. L. ELIASON, HOSPITAL OF THE UNIVERSITY OF PENNSYLVANIA AND PHILADELPHIA GENERAL HOSPITAL

EXPERIENCES WITH THE USE OF SPLANCHNIC AND SPINAL ANESTHESIA FOR UPPER ABDOMINAL OPERATIONS. A STUDY OF 150 CASES

THIS review represents our experience in an effort to avoid the use of general anesthesia in the surgery of the upper abdominal diseases. In this group fall some of the most difficult cases met by the abdominal surgeon. The patients are often poor operative risks, due to long-standing biliary disease, often with jaundice or obesity, or to emaciation and anemia caused by gastric cancer or complicated peptic ulcers. The operations to be performed may require the utmost in technical skill and are often of long duration.

A consideration of these facts makes the selection of an anesthesia of considerable importance. It should be one which gives sufficient relaxation to allow adequate exposure and at the same time it should reduce to a minimum postoperative shock and other anesthetic complications. As a rule, gas (nitrous oxide and oxygen) anesthetic is adequate only for the simpler upper abdominal operations. It has proved especially unsatisfactory in the short, fat, thick-necked type of patient in which group falls a majority of the cases of gallbladder disease. Ether, or gas and ether, gives sufficient relaxation, but its use for the duration of a long operation predisposes to the development of postoperative shock, nausea, vomiting, abdominal discomfort, and respiratory complications. In a control series of 75 upper abdominal op-

erations in which a majority of the patients were relatively good operative risks, there were 10 postoperative deaths. Six patients, 8 per cent, developed pulmonary complications, of whom 2 died of pneumonia. Convalescence was often marred by distention, vomiting, and "gas pains."

Ethylene of all the inhalation anesthetics seems to give fair relaxation with a minimum of shock, but its explosive dangers have prompted many surgeons to discontinue its use.

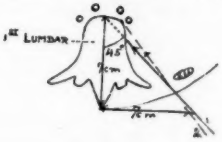
Attention in recent years has been directed to the use of injection anesthesia, either nerve and field block, or spinal block in poor risk patients. By these methods upper abdominal anesthesia may be produced and at the same time a minimum burden is placed upon the vital functions of the body. There is a marked absence of postoperative shock. The present study is one in which two kinds of injection anesthesia were employed, posterior splanchnic combined with local field block and subarachnoid block. We wish to describe our experience with them as found in 75 cases of each type, pointing out their advantages and disadvantages.

SPLANCHNIC ANESTHESIA

Anatomical Considerations.—Kappis and Neumann demonstrated that the sensory nerve supply of the abdominal organs was via the splanchnic nerves. The greater splanchnic arises from the sixth, seventh, eighth, and ninth and sometimes the fifth and tenth dorsal roots. The lesser arises from the lower three thoracic roots. They lie close together on the lateral surface of the thoracic vertebrae and reach the abdomen, the former by passing between the diaphragmatic crura, the latter by piercing the diaphragm. In the abdomen they are found lying on the psoas muscle, just lateral to the midline behind the peritoneum. The fibers from each side join to form the semilunar ganglion, the large sympathetic plexus surrounding the aorta at the region of the celiac axis. From this ganglion fibers pass to form minor ganglia which supply the mesentery, the greater and lesser omentum, the hilus of the kidney, the liver, and biliary system, and the great vessels. The organs of the

lower abdomen and pelvis receive a separate sensory nerve supply from the lumbar cord.

Technic of Splanchnic Block.—The method by which anesthesia of the upper abdomen may be induced by splanchnic block has been discussed by Fischer,[1] Labat,[2] Eliason and Ferguson,[3] and many others, and will therefore be only briefly described. The posterior injection suggested by Kappis was used in all cases. With the patient lying on the side, a needle about 10 cm. long is introduced through a hypodermic wheal 7 cm.



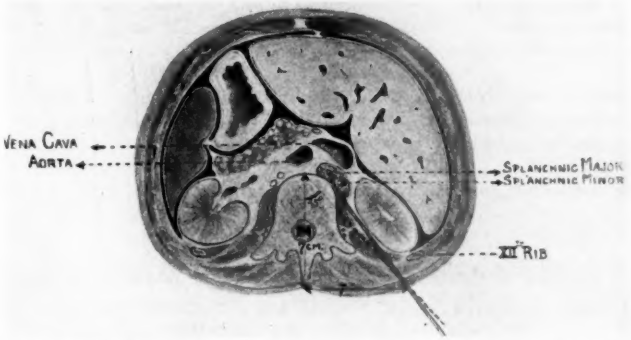


Fig. 606.—Posterior splanchnic anesthesia. Method of insertion of needle at first toward the body of the vertebra and then tangent to it into the retroperitoneal space.

from the spinous processes and opposite the upper portion of the spine of the first lumbar vertebra. Anesthetizing with $\frac{1}{2}$ per cent novocaine solution, the needle is advanced at an angle of 30 to 40 degrees with the sagittal plane for 6 to 8 cm. until the lateral wall of the body of the first lumbar vertebra is reached. By withdrawing and changing the direction slightly forward, the needle can be made to pass tangent to the vertebral body. It is then inserted 1 to 2 cm. forward, through the psoas muscle

until its tip lies in the retroperitoneal space. Novocaine solution must be injected as the needle is advanced because by this means movable tissues such as blood vessels are pushed out of the way and the peritoneum is pushed forward in front of the needle (Fig. 606). Fifty to 60 cc. of ½ per cent novocaine containing adrenalin 10 minims to the ounce, are injected into the retroperitoneal area and the procedure is repeated on the other side. The patient is then draped and a block anesthesia of the upper abdominal wall is given, using ½ per cent novocaine. The operation may be started as soon as the injection is completed and the anesthesia lasts from one to two hours.

TABLE 1

ANESTHESIA RESULTS IN 75 CASES OF SPLANCHNIC BLOCK

Types of operation.	Total operations.	Successful.	Incomplete.	Incompatible.	Failure.
Gastric operations	22	10	10	2	0
Gastric operation and appendectomy	4	1	3	0	0
Exploratory laparotomy	10	8	1	0	1
Operations on gallbladder	22	17	1	1	3
Operation on gallbladder and appendectomy	6	2	1	1	2
Operation on bile ducts	11	6	0	1	4
	75	44	16	5	10

Technical Difficulties.—As the needle is passed toward the retroperitoneal area, blood vessels are sometimes entered. It is important, therefore, that no novocaine be injected without withdrawing the plunger of the syringe. If blood appears in the syringe, the direction of the needle is altered slightly. As experience is gained in the method, a certain elastic resistance is noted when the needle meets a vessel and if this warning is heeded, the larger vessels can easily be avoided. We have never noted any untoward results from puncture of a blood vessel. During long operations the anesthesia of the abdominal wall may wear off, necessitating its renewal before closure of the abdomen. This is usually easily accomplished by the use of a small amount of novocaine solution. At times the anesthesia of intra-abdominal structures is incomplete, so that pain or

retching may occur when pulling downward on the stomach, or in manipulations in the region of the common duct. These two areas involve the gastrohepatic omentum, anesthesia of which may be completed by the injection of 10 to 15 cc. of novocaine solution between its peritoneal layers. Occasionally the appendix may be removed without additional anesthesia, but usually an injection is made into the meso-appendix before appendectomy is performed.

TABLE 2

OPERATIONS PERFORMED UNDER SPLANCHNIC ANESTHESIA

	Number of operations.	Deaths.
Posterior gastrojejunostomy	10	
Posterior gastrojejunostomy and oversewing of ulcer	6	1
Excision of ulcer, pyloroplasty	2	
Gastric resection, polya anastomosis	3	1
Wedge resection, gastric ulcer	3	
Anterior gastrojejunostomy, jejunojejunostomy	2	1
Gastrotomy	1	
Exploratory laparotomy	13	2
Cholecystectomy	11	
Cholecystostomy	10	1
Cholecystostomy, choledochostomy	3	1
Cholecystectomy, choledochostomy	6	1
Choledochostomy	2	1
Choledochoduodenostomy	3	

In 60 cases, 80 per cent of the series, the operation was performed without the use of inhalation anesthesia, although the anesthesia was completed by intra-abdominal injection in about one fourth of these cases. In 15, 20 per cent of the series, the operation could not be finished without gas or gas-ether anesthesia. The failure in 5 cases should have been avoided by a better selection of patients. Highly nervous individuals who are apprehensive about their operations generally do poorly with splanchnic anesthesia, even though they experience no pain. In 3 patients general anesthesia was administered before the operation was begun. The failures in this group we have classed as "incompatible." In 10 cases, 13.3 per cent of this series, the splanchnic injection failed to give anesthesia. In 6 of these cases, there were technical errors which were known to be the

cause of the failure. Four cases were unsuccessful due to widespread peritoneal adhesions. All of these patients had been operated upon previously and a general anesthetic was given because complete anesthesia is difficult to obtain in these cases by splanchnic block.

The group of operations listed in Table 2 gives some idea as to the type of work which can be performed under splanchnic block. Thirty-seven of these patients were extremely poor operative risks, due to gastric malignancy, biliary tract disease, or ulcer complicated by pyloric obstruction. In the group, there were 9 postoperative deaths.

Case I.—Male, age seventy-seven years, with marked dehydration, loss of weight, and a large epigastric mass. Exploratory laparotomy and biopsy. Death on the seventh postoperative day of bronchopneumonia. Necropsy showed large hypernephroma of right adrenal, with extensive involvement of the liver.

Case II.—Male, age seventy-three years, with complete pyloric obstruction due to longstanding ulcer. Death (from pulmonary embolism) four days after posterior gastrojejunostomy.

Case III.—Male, age sixty-five years, emaciated, pyloric obstruction due to gastric carcinoma. Died twelve days after anterior gastrojejunostomy and jejunojejunostomy following rupture of his wound.

Case IV.—Female, age seventy-four years, with pyloric obstruction due to gastric carcinoma. Died twenty-four days after resection of growth and Polya operation. Necropsy showed no intra-abdominal cause for death. Lungs were clear. Death probably due to cardiac degeneration.

Case V.—Female, age fifty-five years, with jaundice of one week's duration. Exploratory laparotomy showed carcinoma of the pancreas and extensive hepatic metastasis. Death on the fifth day after operation of cardiac failure.

Case VI.—Female, age forty years, with jaundice of five weeks' duration, temperature of 102 F., diagnosed acute biliary obstruction. Operation showed no cholelithiasis; cholecystostomy. Bile removed at operation showed pure culture of hemolytic streptococcus. Death three days after operation. Necropsy diagnosis: acute hepatitis.

Case VII.—Male, age sixty-five years, with jaundice of four weeks' duration, and chronic alcoholism. Cholecystostomy and choledochostomy,

with removal of gallstones. Death on seventh postoperative day of hepatic insufficiency.

Case VIII.—Female, age sixty-four years, with jaundice of four weeks' duration. Choledochostomy performed, with removal of common duct stone. White bile in common duct. Died on nineteenth day after operation, of delayed liver shock.

Case IX.—Female, age thirty-nine, with jaundice of four weeks' duration. Cholecystectomy and choledochostomy, white bile found. Died on sixth postoperative day of secondary hemorrhage. This patient is the only one of those which died where the anesthesia failed and ether was given.

Complications.—*Table Complications.*—In about 73 per cent of the cases, a fall in blood pressure occurs within ten to thirty minutes after splanchnic injection. The fall varies from 20 to 90 mm. of Hg averaging between 40 and 60 mm. Because of this phenomenon sphygmomanometer readings are made at five-minute intervals by the anesthetist before and during the operation. The depression of blood pressure at first caused considerable anxiety, but further experience showed that there need be no cause for worry. The patients were treated by lowering the head of the table and the hypodermic administration of caffeine sodiobenzoate, 3 grains, adrenalin, 5 minims, or ephedrine sulphate, 50 to 100 mg. In no case was it necessary to give an intravenous infusion while the patient was on the operating table. In nearly all cases the blood pressure had returned to the normal level by the time the operation was completed.

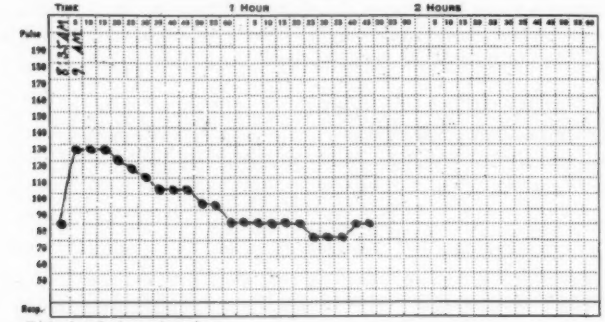
In comparing the blood pressure and pulse charts of these patients, it was noted that even with the fall in blood pressure commonly found, the pulse showed no increase in rate in at least 70 per cent of the cases, and in about one half of these there was an actual fall in pulse rate (Fig. 607).

Postoperative Complications.—There were 3 patients in the 75 who developed pulmonary complications, 1 died of bronchopneumonia and another of pulmonary embolism (vide supra), and a third developed a mild bronchitis, an incidence of 4 per cent.

ANESTHESIA AND BLOOD PRESSURE RECORD.

NAME Mr. Walter W. Age 61 yrs. HOSPITAL University. INDEX FILE No. 10431 VOL.

ANESTHESIA CHART.



Posterior Gastro-enterostomy

Operation Oversewing of ulcer Appendectomy, Date 2-4-27. Operator Dr. Eliason

Operation Started 9 A.M. Operation Ended 10:40 A.M.

Anesthetic Posterior Splanchnic

Variety Novocain ½%. Method Anesthetizer Dr. Ferguson

Time to Anesthetize Amt. to Anesthetize 130 cc. Total Amt. used

Examination of chest (before) O.K.

BLOOD PRESSURE CHART.

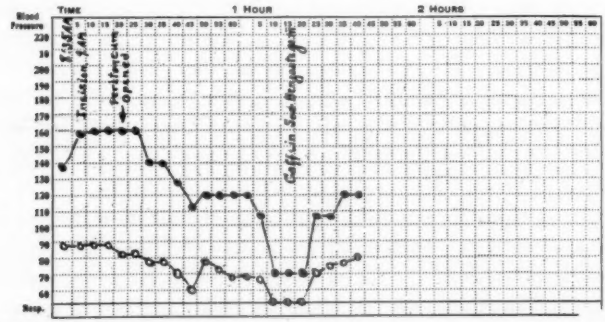


Fig. 607.—Pulse and blood pressure chart of case operated on under splanchnic block. Note fall of pulse, even with fall of blood pressure, and rise of blood pressure after caffein sodiobenzoate injection.

Two jaundiced patients developed delayed hepatic insufficiency of which one died. Secondary hemorrhage was the cause of a fatality in another patient with biliary obstruction. Two

patients had a rupture of their wounds closed under local and splanchnic block.

Abdominal complications, vomiting, distention, abdominal cramps, etc., occurred very infrequently and the convalescence was strikingly uneventful in most cases.

Advantages.—Splanchnic block offers a method of anesthesia for use in upper abdominal surgery which produces a minimum of shock and a convalescence which is relatively free from complications. It is of especial value for operation upon patients who are regarded as poor surgical risks.

Disadvantages.—Two posterior injections and an anterior abdominal block must be given, a time-consuming procedure for the surgeon and somewhat of a nervous strain for the patient. The anesthesia is not always complete and in 20 per cent of our cases inhalation anesthesia had to be given. It cannot be easily used in the highly nervous patient, nor in the patient on whom a previous operation has been performed. Postoperative adhesions are not well anesthetized by splanchnic block. Associated with splanchnic injection there is a fall of blood pressure in about three fourths of the cases.

SPINAL ANESTHESIA

Introductory Comments.—The commonly accepted field of usefulness for subarachnoid block or so-called "spinal anesthesia" has been in operations on the lower abdomen or extremities. It may well be extended, however, to the upper abdomen. Here it provides an incomparable relaxation of the abdominal wall, providing an ease of exposure unobtainable with any other form of anesthesia. Added to this are the advantages of minimized shock in seriously ill patients and an immediate postoperative convalescence free from the nausea, retching, and distention attendant upon an inhalation anesthesia. Such are the attractions spinal anesthesia offers to the surgeon for his difficult upper abdominal work. On the other hand, its inherent shortcomings appear at first glance to restrict its usage in this field. There is a popular mistrust of high levels of anesthesia and the well-recognized time limitation. Both of these may

largely be overcome by experience in the use of the method. A study of our cases shows that most of the failures were ours and not those of the method itself. We feel that the advantages far outweigh the disadvantages.

Our material for review consists of seventy-five consecutive operations through a supra-umbilical incision in which anesthesia of the entire peritoneal cavity was required. Explorations or other operations done through an incision in the abdominal wall below the umbilicus have been excluded. Although in many of these latter cases, anesthesia may have been sufficient for gastric or gallbladder work, we have not definite proof of it. The various types of procedures performed are classified in the table.

TABLE 3

Types of procedure.	
Operations on the stomach and duodenum	36
Operations on the gallbladder and ducts	23
Exploratory laparotomies, including lysis of adhesions	12
Splenectomy	1
Resection of transverse colon	1
Drainage of subhepatic abscess	1
Relief of huge strangulated incisional hernia	1
	75

Technic.—Five different surgeons have made the injections. There has been therefore a relatively large factor of inexperience and minor variations in technic. Two drug preparations have been used: Neocaine (Anglo-French Drug Company) and spinocaine (Pitkin-Metz). Neocaine is novocaine in crystalline form. The crystals are dissolved directly in spinal fluid which is then reinjected. The level of anesthesia is gauged by the amount of fluid used to dilute the dissolved drug and by the force used in the injection. Spinocaine is 10 per cent novocaine in an alcoholic aqueous solution together with minute amounts of gliadin and strychnia. It is of lower specific gravity than spinal fluid. Accordingly its level may theoretically at least be influenced by alterations in axis of the patient's body in addition to the control of the factors noted for neocaine. The duration of the anesthesia period in any case is largely a func-

tion of the dosage of anesthetic agent. For upper abdominal work 3 to 4 cc. of spinocaine (representing 300 to 400 mg. of novocaine) or 200 mg. of neocaine are required. There has been no noticeable difference in the results obtained with the two preparations and their choice has been one of individual preference.

Punctures are preferably made in the second or third lumbar interspace with the patient in the lateral decubitus position. Introduction of a needle above this level is fraught with danger of injury to the spinal cord. Occasionally in patients with hypertrophic spondylitis or spinal curvatures it may be impossible to perform lumbar puncture with the patient lying down. In such instances the use of a sitting posture makes the procedure easier but at the same time undoubtedly increases the risk of a respiratory catastrophe. Ephedrine (50 mg.) is routinely given with the novocaine used to anesthetize the skin for lumbar puncture. For the puncture a needle of small gauge (No. 21) with a short bevel is best as it leaves the smallest opening in the membranes. It is of the utmost importance that the entire aperture at the end of the needle lies within the subarachnoid space as the injection is made. Otherwise part of the solution may be injected between or outside the membranes and poor results are inevitable. This point cannot be too strongly emphasized in connection with the induction of a satisfactory anesthesia of the upper abdomen. For pelvic work a careless injection may prove successful, but the utmost pains must be taken to secure a perfect injection for the type of cases under consideration. The position of the needle is correct if the pressure of the cerebrospinal fluid itself or very slight suction upon the piston will permit aspiration of fluid into the syringe. At times only a slight advance or withdrawal of the needle or even its rotation *in situ* may serve to provide the desired flow. In cases of doubt as to the position of the needle, a puncture at another level may be done. Immediately after injection the head of the table is tilted downward at an angle of about 20 degrees with the horizontal.

Anesthesia Results.—Major upper abdominal surgery requires the maintenance of anesthesia to the sixth dorsal segment for from

an hour to an hour and a half. The requirement of extent can be easily met by proper dilution and diffusion of even a small amount of drug. The time duration of anesthesia is then increased at will by augmenting the dosage. In so doing, however, we approach the danger zone. Only by experience does one gain the ability to gauge in a given case the degree of dilution and dosage of drug adequate for the operation under consideration and at the same time compatible with safety. Our inclination throughout this series of cases has been to be over-cautious. Often we have been forced on this account to resort to inhalation anesthesia to complete the closure. These cases should not be regarded as failures of the anesthesia. Furthermore, as experience increases they shall become more infrequent. Moreover, the toxic effect of the small amount of ether necessary for closure of the abdomen is not comparable to that in which ether is used throughout.

An analysis of results shows that in 46 cases, or 64 per cent, spinal anesthesia was entirely satisfactory and no augmentation was required. The average time consumed for these operations was sixty-seven minutes. The actual duration of anesthesia was of course longer in every case. The longest operative procedure carried on under spinal alone was one hour and forty-five minutes.

The results are shown in Table 3.

TABLE 4

Anesthesia results.		
Entirely successful		46 (64 per cent)
Partially successful		22 (29 ")
Fault of anesthetic	13	
Fault of operator	4	
Fault of patient	5	
Failure		7 (9 per cent)
		75

This tabulation requires further explanation. Partial successes are those cases in which anesthesia was high enough to permit of performance of a portion of the operation, but not prolonged enough to allow of its completion. The explanation was found in most instances in technical errors. Either too small a dosage was chosen or an adequate dosage was not injected in such a manner as to give the proper level of anesthesia for the

full time required. In 9 of these 13 cases, there was satisfactory anesthesia for an hour or more and augmentation was required only for closure. In most instances of this sort relaxation can not be secured by nitrous oxide. The diminished vital capacity incident to restricted thoracic expansion under spinal anesthesia prevents a proper saturation of alveolar air for full anesthetization. Ether must be resorted to.

In another group of partial successes we feel that the anesthesia itself fulfilled all reasonable expectations. The operation was unduly prolonged past an hour and a quarter by the deliberations of a slow or inexperienced operator. The responsibility for failure rests therefore on him rather than upon the method.

There is a final group of cases in which the result was marred by the patient's incompatibility. Pain impulses were satisfactorily blocked, but other impulses were interpreted as painful. These patients complained of a sense of suffocation, of oppression, of impending death, or became restless under the imposed restraint of their position. Gas analgesia was accordingly required to complete the operation. In an effort to eliminate this group of patients who are temperamentally unsuited to any type of conduction block anesthesia, we now make it a rule to discuss the anesthesia problem with each patient prior to operation. In any case where there is an expressed preference for "being put to sleep" or any unusual apprehensions about the projected operation, general anesthesia is promptly advised.

Mortality.—There were five postoperative deaths in this group which included many extremely poor operative risks. None of the deaths could be attributed to the anesthetic either entirely or in part.

Case I.—Cachectic dehydrated woman of sixty years, with carcinoma of gallbladder. Exploratory laparotomy. Death on tenth day from a pyloric obstruction inevitable from metastases.

Case II.—Apparently robust male of fifty-two years. Extensive nonmalignant gastric ulcer and chronic calculous cholecystitis. Wedge resection of stomach and cholecystectomy. Died on third day. Autopsy showed no cause of death, which was apparently due to operative shock.

Case III.—Splenomegalic, age fifty years, probable Banti's disease, with associated hepatic cirrhosis. Splenectomy. Death followed massive hemorrhage into bowel on eighth day.

Case IV.—Feeble female of seventy years. Duodenal ulcer. Gastrojejunostomy. Death on fifth day from probable pulmonary embolism. (Clinical diagnosis.)

Case V.—Inoperable carcinoma of stomach in man of sixty-six years. Pyloric obstruction. Posterior gastrojejunostomy. Developed bilateral parotitis and suppuration in wound. Became suddenly hemiplegic and died on fifteenth day. Autopsy showed extensive metastases.

Complications.—(*a*) *Table.*—There are two common occurrences during the course of the anesthesia. The operator may be alarmed by a fall in blood pressure of from 10 to 100 mm. The patient on his side may be annoyed by a sense of suffocation and nausea. These two phenomena may not occur coincidently. The underlying physiologic mechanism of the fall in blood pressure is not understood. We are at present engaged in experimental studies which indicate that the usual explanation of a vasodilator effect from splanchnic nerve paralysis is inadequate. Contrary to the logical expectation there is no compensatory acceleration of the pulse rate coincident with the fall in blood pressure in 40 per cent of the cases. In our experience stimulants such as adrenalin, ephedrine, pitressin and vasopressin have slight influence on this blood pressure level once the fall has occurred. Intravenous infusion of saline or glucose can be depended upon to elevate the pressure, however, and we have felt called upon to use it on three occasions. At the present time we are not concerned about the level of the blood pressure provided the patient's condition remains otherwise satisfactory. There is always a return to a normal level as the anesthesia wears off.

The nausea and suffocation are doubtless due to the marked restriction in thoracic respiratory movements. Intercostal ennervation being blocked, respiration is carried on largely by the diaphragm through the phrenic nerve which arises from the third to the fifth cervical segments. Inhalations of carbon dioxide, by increasing the amplitude of respiration, serve to re-

lieve these sensations so distressing to the patient and sometimes annoying to the operator.

In 2 cases we have encountered severe respiratory difficulties. In the first case, a cholecystectomy was done on a young, apparently robust man. The blood pressure fell steadily throughout the operation although there was no hemorrhage. The operation was concluded in an hour, at which time the blood pressure was 70/48 and the pulse was 90. Ten minutes later, the patient having been left on the operating table, there was a sudden collapse with cyanosis and cessation of respiration. The pulse was 60 and of fair quality although the blood pressure could not be obtained. Adrenalin was administered. Artificial respiration and intravenous saline were started. After ten minutes, periodic breathing began, later becoming normal in type. This type of collapse, although obviously primarily respiratory in nature, is extraordinary in that it occurred so long after the induction of the anesthesia. The second instance is more typical of the usual respiratory embarrassments reported. Anesthesia was induced with the patient in a sitting posture owing to difficulties with the lumbar puncture. There was instantaneous suspension of respiration. Artificial respiration and inhalations of carbon dioxide were given. After four minutes normal respirations returned and there was no further trouble. This appears as a clear-cut case of permeation of the anesthetic drug into a high level of the spinal canal, with resultant respiratory paralysis. It also illustrates the dangers of the sitting posture for injection.

(*b*) *Postoperative.*—Headache is the only postoperative complication with which we have had experience. It occurred once in this group. Beginning on the day after operation it appeared whenever the head was elevated and was absent while the patient was flat. Medication had slight influence upon it, but it disappeared spontaneously after four days. Urinary retention, gauged by the need for catheterization, has had about the same incidence as with a similar group of cases operated upon under general anesthesia. Our records do not give any accurate index of the exact amount of postoperative nausea, vomiting, and distention experienced. We have a firm conviction, however, that

ANESTHESIA AND BLOOD PRESSURE RECORD.

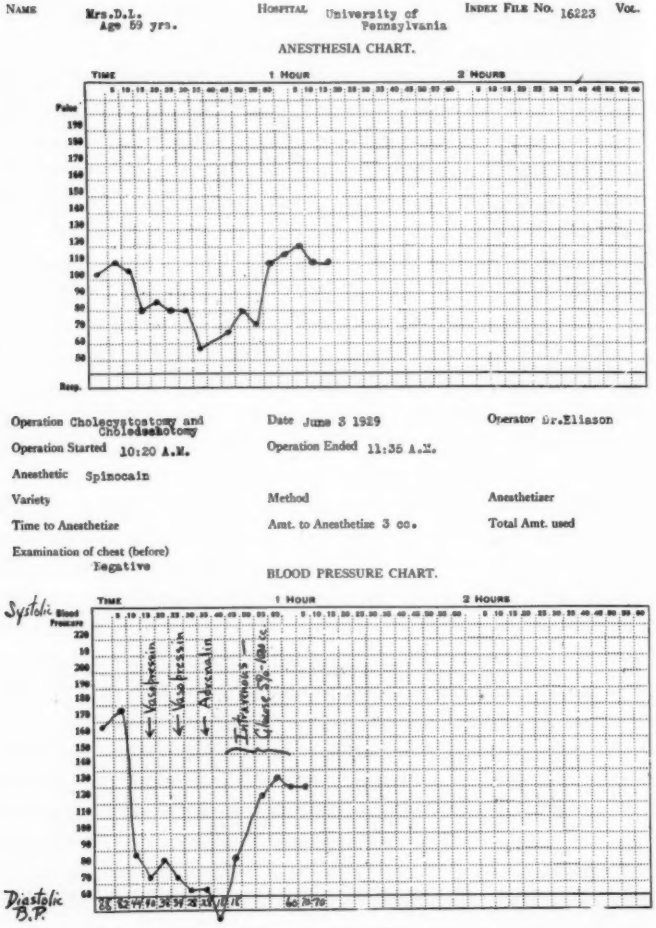


Fig. 608.—Pulse and blood pressure curve from case operated under spinal anesthesia. Note fall in blood pressure accompanied by slowing of pulse. Also note the failure of stimulants to raise pressure and immediate response to intravenous infusion.

these patients pass through a far less uncomfortable immediate postoperative period than do those who have had inhalation anesthesia. Fluids may be given by mouth earlier because of the absence of postanesthesia nausea. There is less trauma to the viscera during operation because relaxation is so complete. Accordingly the postoperative gas pains and distention are greatly diminished. In our series there were only two instances of postoperative pulmonary complication—an acute bronchitis and a lobar atelectasis. Both recovered. This is an incidence of 2.7 per cent in a selected group of cases in which the ordinary incidence of pulmonary complication is known to be very high.

Advantages and Disadvantages.—The incomparable relaxation of the abdominal wall provided by spinal makes it preeminent for operations upon perforated ulcers and for thorough explorations of the abdomen. There is no toxic effect on the organisms as a whole. There is a blocking of pain impulses during the operation, fulfilling the requirements of Crile for the avoidance of shock. The calm of the postoperative period has been commented upon. These are considerable advantages over the old type of deep prolonged ether narcosis.

On the other hand there is the element of unreliability. This will become minimal as the experience of the anesthetizer increases. The brief duration of the anesthesia must also be considered as a disadvantage, particularly since the failure of anesthesia generally calls for ether to permit of closure of the abdomen. Nevertheless, the toxic effect of the small amount given for this purpose is only a fraction of that occurring when gas and ether are given from the outset. The traditional dread of a respiratory catastrophe still persists. We believe, however, that with the passage of time and the accumulation of more and more reports of safe spinal anesthesias, this bugaboo will recede into the background. We do not employ spinal in the group of incompatible patients described above or in those who are orthopneic or whose systolic blood pressure is below 100. However, we are firmly convinced that there is a great field for this type of anesthesia in upper abdominal surgery.

SUMMARY AND CONCLUSIONS

We have reviewed a group of operations upon the upper abdomen, performed with the aid of splanchnic and spinal anesthesia, 75 cases of each. The advantages and disadvantages of the two methods have been discussed. They possess in common certain advantages over the inhalation group, chief among which are minimizing of the toxic effects and operative shock, together with a diminution in postoperative discomforts and complications. On the other hand, they involve a certain element of risk inherent to all anesthetic agents. There will always be a certain small proportion of cases in which anesthesia is not obtained. The period of anesthesia is strictly limited and there is an accompanying sharp fall in blood pressure which must be taken into consideration. Finally, these forms of anesthesia are not suitable for use in a considerable group of highly nervous apprehensive patients.

Spinal anesthesia presents a few distinct advantages over splanchnic. The latter requires a complicated, somewhat delicate technic of induction, involving three needle punctures which may be annoying to nervous patients. Spinal anesthesia is simple and almost painless. Splanchnic is unsuitable in cases with intraperitoneal adhesions. Spinal provides a degree of relaxation and facility of exposure which is not paralleled by any other anesthesia.

This study has been presented with the hope that the experience we have gained therefrom may be of some benefit to others as it has to us in making easier and safer that difficult field of surgery, the upper abdomen.

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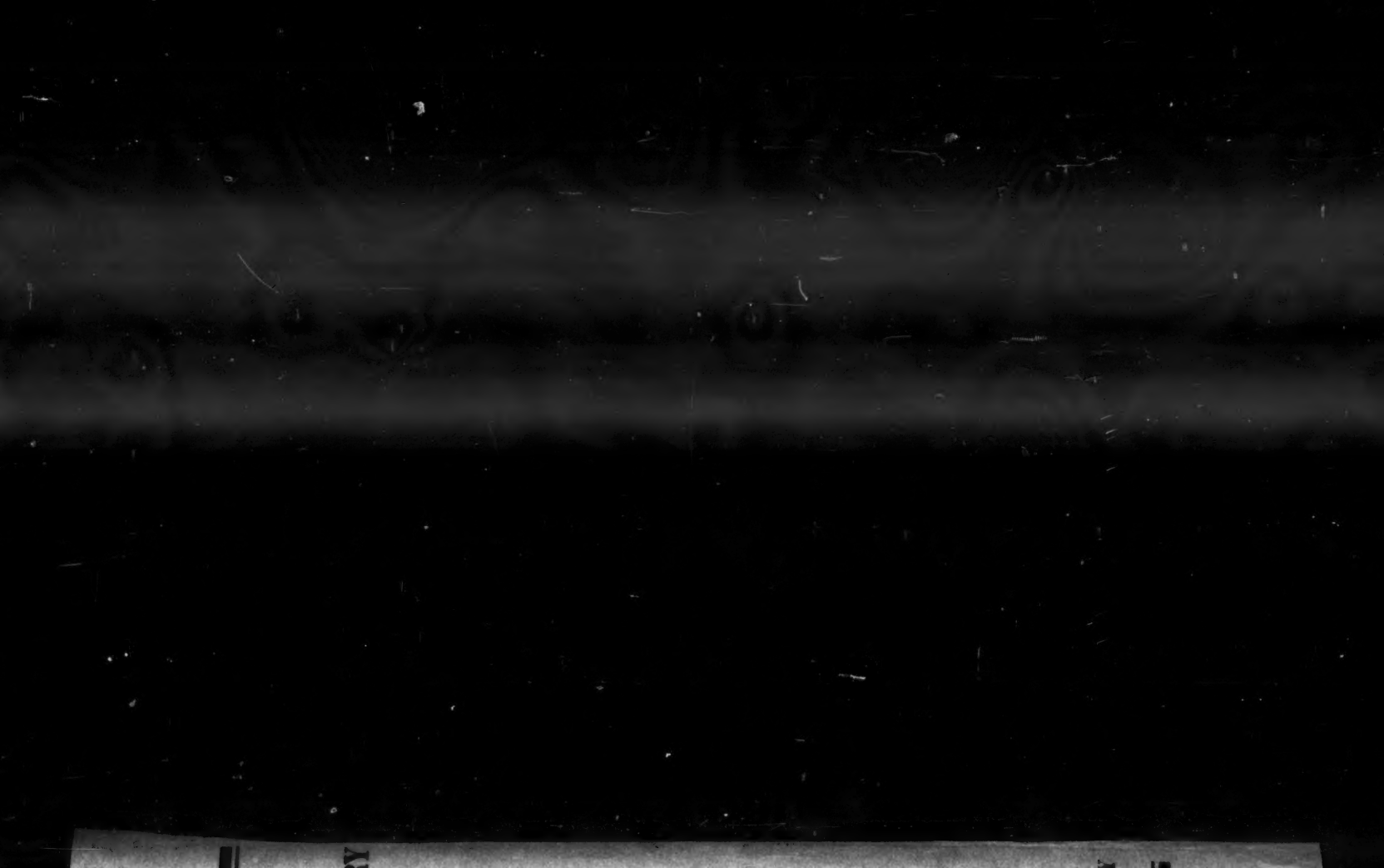
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